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SCIENCE, AS DEFINED FOR THE SCHOOL CLASSROOM

In September 2006, *Truth in Science* (TiS) sent a free resource pack to the head of science in every UK secondary school and sixth form college. The pack contained a DVD, '*Where does the Evidence Lead?',* and a teacher's manual. The DVD consists of six 10-minute sections of film, suitable for classroom use. The TiS project is seeking to encourage the teaching of intelligent design, not creationism, in science classes. The pack describes and critiques Darwin's theory of evolution on a scientific basis. It also shows scientific evidence suggesting that the living world is intelligently designed and that Darwinian processes cannot bring about these designs.

Hansard for 1 November 2006 records a question from Graham Stringer, MP, asking the Secretary of State for Education and Skills what advice he planned to give to schools on the information pack circulated to all schools by TiS.

Jim Knight, Minister of State, Schools and 14-19 Learners answered*: 'It is up to schools to decide what teaching resources they need to help them deliver the national curriculum for science effectively. Neither intelligent design nor creationism are recognised scientific theories and they are not included in the science curriculum. The Truth in Science information pack is therefore not an appropriate resource to support the science curriculum.*

The national curriculum for science clearly sets down that pupils should be taught: how uncertainties in scientific knowledge and scientific ideas change over time; the role of the scientific community in validating these changes; variation within species can lead to evolutionary changes; and, similarities and differences between species can be measured and classified.'

Earlier in 2006 the then Minister of State, Schools and 14-19 Learners, Jacqui Smith, MP, wrote to David Howard, MP for Cambridge, following his approach to the Education Secretary with concerns from some constituents over the teaching of creationism in schools. The following are extracts from her letter (available complete at http://www.bcseweb.org.uk/index.php/Main/TheUKGovernmentsPosition):

Creationism cannot be used as an example of a scientific controversy as it has no empirical evidence to support it and no underpinning scientific principles or explanations. It belongs in a different realm of knowledge, that of religion.

Intelligent design is sometimes erroneously advanced as a scientific theory but it has no underpinning scientific principles or explanations supporting it and it is not accepted by the international scientific community.

An e-petition to the government from a group called *Science Just Science* elicited a response on 21 June 2007 which contained the following points:

The Government is aware that a number of concerns have been raised in the media and elsewhere as to whether creationism and intelligent design have a place in science lessons. The Government is clear that creationism and intelligent design are not part of the science National Curriculum programmes of study and should not be taught as science.

We will be publishing guidance for schools, on the way creationism and intelligent design relate to science teaching. It will be possible to ensure that the weight of scientific opinion is properly presented. The guidance will be available on the Qualifications and Curriculum Authority website in due course.

The guidance referred to above was duly produced and is available at (http://www.teachernet.gov.uk/docbank/index.cfm?id=11890).

Key extracts from this guidance (hereafter referred to as 'the guidance') are:

Students learn about scientific theories as established bodies of scientific knowledge with extensive supporting evidence. Hypotheses are developed on the basis of the body of knowledge and are tested experimentally to generate further evidence that may be supportive or contradictory. Experimental work can then be used to generate further evidence in order to test new hypotheses based on these bodies of scientific knowledge. The role of the scientific community in evaluating and validating new work is also included as is the nature of, and evidence for, evolution.

Creationism and intelligent design are sometimes claimed to be scientific theories. This is not the case as they have no underpinning scientific principles, or explanations, and are not accepted by the science community as a whole. Creationism and intelligent design therefore do not form part of the science National Curriculum programmes of study.

Any questions about creationism and intelligent design which arise in science lessons, for example as a result of media coverage, could provide the opportunity to explain or explore why they are not considered to be scientific theories and, in the right context, why evolution is considered to be a scientific theory.

Science teachers can respond positively and educationally to questions and comments about creationism or intelligent design by questioning, using prompts such as 'What makes a theory scientific?', and by promoting knowledge and understanding of the scientific consensus around the theories of evolution and the Big Bang.

Any resource should be checked carefully before it is used in the classroom. If resources which mention creationism or intelligent design are used, it must be made clear that neither constitutes a scientific theory.

The government's position is made clear throughout these replies and the essential messages are:

- Creationism and intelligent design (ID) are not scientific theories;
- Creationism and ID have no part in the National Curriculum for science and they should not be taught in science lessons;
- A scientific theory must be based on underpinning scientific principles or explanations, and must be accepted by the international scientific community as a whole;
- Creationism and ID can only be discussed negatively in science lessons if questions arise;
- Evolution and related theories are only to be positively discussed in science lessons;
- Creationism and ID can only be discussed positively, if at all, in a beliefs context.

These messages hold no surprises for many familiar with this area, for example, read Paul Taylor's experience and analysis in 'Truth, lies and Science education' (Day One publications). In this article, we consider four key questions they raise together with recommendations for action.

1. Is the government's definition of a scientific theory adequate and reasonable?

It is essential to address this question because scientific theory is used as the filter to determine whether or not any aspects of science associated with creationism and ID can be taught in schools.

The guidance states: *Creationism and intelligent design are sometimes claimed to be scientific theories. This is not the case as they have no underpinning scientific principles, or explanations, and are not accepted by the science community as a whole.*

The guidance leads us to the immediate conclusion that the government's definition of a scientific theory is not adequate and reasonable. This is because no definition is given here of what is meant by *scientific principles,* or *scientific explanations.* These terms are not self-evident and there is a range of views and opinions on what constitutes a scientific theory. A glossary at the end of the guidance is more specific and a little more helpful. It explains that a scientific theory is '*a consistent, comprehensive, coherent and extensively evidenced explanation of an aspect of the natural world which can, at least in principle, be tested by observations and/or experiments…*'

What is meant by 'testing' is not explained, but is a key feature of the scientific process, having both a positive aspect – can we repeat and extend the observations? – and a negative aspect – can

we find evidence that contradicts the theory? The term 'in principle' has to be added in the context of evolutionary theory, since the wider and most controversial application of that theory – species to species evolution – cannot be tested in practice. Theories have degrees of robustness; generally, the more sensitive a theory is to falsification and the more it resists attempts to falsify it, the more robust it is. The robustness of evolutionary theory is therefore many orders of magnitude less than that of theories such as the kinetic theory of gases or quantum theory, with which it is commonly and unjustifiably aligned.

The process of challenge and refutation is particularly important, and, although mentioned in the guidance, is never directed at evolutionary theory. This makes it difficult to avoid the conclusion that the guidance deliberately attempts to avoid the obvious question: what scientific evidence can and is used to test evolutionary theory? The nearest the guidance comes to discussing this important process is in the context of 'how science works' (see Question 3 below).

'a scientific theory must not only be expressed,
but be the subject of cogent argument'

The second question raised in the paragraph we have quoted is whether a scientific theory, in order to be a scientific theory, must be accepted by the scientific community as a whole. Such acceptance is clearly desirable because it gives a theory status and suggests that many great minds have considered the finest detail and concluded that it is soundly argued and supported by appropriate data. The motto of the Royal Society – *Nullius in verba (on the words of no one)* – supports the idea that a scientific theory must not only be expressed, but be the subject of cogent argument, by the scientific community.

Jacqui Smith, the government minister quoted earlier, has asserted that evolutionary theory enjoys the weight of scientific opinion. Weight of opinion, however, is too closely related to groupthink ever to be more than, at very best, a pointer. The guidance and other governmental statements offer no arguments or references to arguments to clarify and justify the government's faith in the view of the scientific community as a validating body of opinion. Consequently, to pray in aid *the weight of scientific opinion* has no significant value.

Since the government is responsible for the education of the majority of the nation's children, and is providing guidance on a key debate in science, and in science teaching, we should expect clarity of expression and a comprehensive explanation and justification of its position.

2. Are creationism and intelligent design scientific theories?

The guidance states '…*they* (creationism and ID) *have no underpinning scientific principles, or explanations…'* An absolute and unequivocal statement such as this is always going to be difficult to justify and defend, and so it proves.

The term 'creationism' is generally taken to be the view that God created the world and universe in six, 24-hour days. As described in the first chapter of Genesis, living creatures, including man, were created as separate species. Man did not develop or evolve from anything less than man, and man was made in the image of God. This understanding of creation is not a scientific theory, since it is derived solely from biblical knowledge. It does, however, drive and stimulate scientific research into origins and the explanation of origins, and seeks to provide scientific evidence and reasoning which challenges and refutes elements of evolutionary theory. The government's guidance appears mistakenly to equate a mixture of science and non-science with one which is totally non-science. Were this to be true, all science would be non-science.

In his book *Personnel Knowledge,* Michael Polanyi has shown very clearly that scientific endeavour is never pure, objective observation and reasoning. Observations require observers, and observers bring their own personal knowledge to the observations, and to the reasoning which seeks to explain and relate them. Hypothesis, the precursor to theory, requires imagination and creativity (as the guidance points out), and these cannot be free from personal knowledge. Personal knowledge is often hidden and unconscious and can sometimes be labelled as intuition. If science inevitably flows from or is mixed with personal knowledge, then the science must be judged on its merits, not on the nature of the personal knowledge to which it is linked.

Although the guidance leaves room for discussion of this in the classroom, it leaves a huge hole in the positive teaching of science, and in particular fails to cover the relationship and meeting-point of belief and science. This last point is discussed further under Question 4.

ID is much less closely linked to biblical revelation. Indeed, its key advocates distance it completely from biblical or religious foundations, emphasising its scientific base and application. This distancing has often been derided by opponents, but the reality which ID promotes is that complex biological systems, for whatever reason, indicate, from observation alone, intelligence. This intelligence can be and is analysed without reference to a particular designer. The observation of intelligence in biological systems is nothing new. What characterises today's ID movement is that this observation is stated in the form of objective, scientific criteria.

ID advances the idea that intelligence is linked to complexity, and sets out rules for judging whether the complexity in biological systems rules in, or rules out, direct Darwinian pathways to biological entities with distinct functions.

Information theory is also a key feature of ID because simple biological entities can only evolve to more complex entities, it is argued, if there is a 'blueprint' or information available to 'tell them' what they should become. ID argues that this information is available to allow variations within species to occur, but is not available to allow species-to-species evolution by natural, known processes. If this was found to be universally true, species-to-species (macro) evolution would be dead.

Irreducible complexity, a key feature of ID, is a topic also addressed in the government guidance: '*A structure is claimed to be irreducibly complex if it could not have originated by natural*

processes; this claim is made for any biological system consisting of many interacting parts in which the absence of any one part means that the whole system does not function. Two examples which have been frequently quoted are the mammalian eye and the bacterial flagellum. Plausible mechanisms by which both could have evolved have now been described.'

The latter statement is justified by reference to a paper by Howard van Till [2003] and Richard Dawkins' book *Climbing Mount Improbable* [1996].

Two significant observations can be made about the government's approach in the above paragraph.

First, *plausible* does not convey robustness or command confidence but rather points to the insecurity of the evolutionary position, which lies in the fact that no-one has observed, nor can observe, species-to-species evolution. Secondly, the debate has moved on since the two publications, and the views expressed have been vigorously refuted. The guidance has not followed the debate and fails to mention or reference contradictory material. This points strongly to bias.

Is ID a scientific theory? Yes, because it satisfies key scientific principles and it only fails the government's criteria on the debatable and possibly untrue view expressed in the guidance of not being 'widely accepted.'

Interestingly, the Royal Society, in outlining its views on why creationism and ID should not be taught in science lessons, refers to ID as ID theory. It dismisses the theory, without justification, on the basis that it is not supported by the weight of scientific *evidence* – note, not on the basis of the weight of scientific *opinion* as used in the Jacqui Smith statement – and on the wholly unsupported statement that it has more to do with religion than science.

ID has solid scientific credentials and there is no reason why its main statements and features, together with its implications for evolutionary theory, should not be taught in science classes. To say, as the guidance does, that 'ID lies wholly outside of science' is staggeringly inept, since even the Royal Society implies that it has some weight as a scientific theory. This indicates strongly that the writers of the guidance do not understand and/or do not want to understand what they are talking about.

3. Does the application and teaching of science in a topic area require the pre-existence of a scientific theory?

The government's guidance clearly admits only one criterion for allowing science to be taught in science lessons, in this topic area, which is that the science must be enshrined within a generally accepted theory. This misleading, unjustified and stifling position needs to be challenged. Scientific investigation and method constantly produce new scientific theories, and the evidence and arguments which refute existing theories. A good theory can be destroyed on the basis of one

good experiment. It would hardly be reasonable to exclude the teaching of the details of such an experiment simply because it didn't fit the definition of a scientific theory. The way in which the government has framed its guidance allows no scientific challenge to evolutionary theory and no method of assessing the robustness or otherwise of the theory. It ignores the reservations and challenges from both within evolutionist ranks and from outside.

Creationism and ID are not completely forbidden from the science classroom, for the guidance goes on to say: '*Science teachers can respond positively and educationally to questions and comments about creationism or intelligent design by questioning, using prompts such as "What makes a theory scientific?", and by promoting knowledge and understanding of the scientific consensus around the theories of evolution and the Big Bang.*'

The guidance further states: *'If questions or issues about creationism and intelligent design arise during science lessons they can be used to illustrate a number of aspects of how science works. Such aspects include: "how interpretation of data, using creative thought, provides evidence to test ideas and develop theories"; "that there are some questions that science cannot currently answer, and some that science cannot address"; "how uncertainties in scientific knowledge and scientific ideas change over time and about the role of the scientific community in validating these changes".'*

It also very helpfully says *'Students learn about scientific theories as established bodies of scientific knowledge with extensive supporting evidence. Hypotheses are developed on the basis of the body of knowledge and are tested experimentally to generate further evidence that may be supportive or contradictory. Experimental work can then be used to generate further evidence in order to test new hypotheses based on these bodies of scientific knowledge. The role of the scientific community in evaluating and validating new work is also included as is the nature of, and evidence for, evolution.*'

Some of these clauses are a good summary of the science process and come across in an encouraging way until it is realised that *how science works* means, in this context, how science works to promote evolution and discard unreasonably anything which challenges it; that *developing hypotheses and generating supporting and contradictory evidence* means not discussing or giving fair consideration to hypotheses and scientific arguments that contradict evolutionary theory.

As a consequence of this blinkered guidance, fundamental features and activities of scientific endeavour are being denied to the nation's children in a topic area where it most needs to be understood and applied. Additionally, how can an area of scientific endeavour ever grow and gain ground, as its content deserves, if it is dismissed without proper debate and while those who might profitably pursue it are deprived of its insights in their formative years?

4. Where do science, religious and other studies meet, and how do we decide where and how they overlap?

To put things in perspective, it is worth pointing out that most scientific endeavour does not suffer from the troubles that beset the study of origins. This is because most science is concerned with a

stable universe with stable laws and reproducible events. We experience the fruits of scientific endeavour daily and when it works there is little need for most people to question the underpinning science, or its relationship with other areas of knowledge. Origins, however, constitute a singularity which brings science and faith sharply together.

To understand this amalgam requires particularly careful thought and reasoning, and structured and objective debate conducted in a non-adversarial manner. Unfortunately, these requirements are rarely met. Debate is often polarised and adversarial and exchanges are prone to degenerate into character attacks. A statement on this issue by the Royal Society is one of the more restrained and measured statements from a learned body promoting the non-admission of creationism and ID into science lessons. Nevertheless it strays beyond science by, for example, expecting the reader to extrapolate from the readily observable acquirement of bacterial resistance to the non-observable development of bacteria into man.

The Committee on Culture, Science and Education of the European Parliament has issued its own long and detailed statement on *The Dangers of Creationism in Education*. As the title admits, it is not an attempt to present a balanced picture and it too degenerates (for example, paragraph 42) into a desperate non-scientific position by calling on the reader to draw parallels between early 20th century views of atomic theory and the development to the current understanding, and the current understanding of evolutionary theory and its likely status in the future. This is simply asking the reader to engage in an act of intuitive faith and optimism.

Assuming that these august bodies set out to present a case rooted in rational scientific argument then their attempts illustrate how soon science drops out and faith, beliefs and personal knowledge 'kick in'.

The guidance consigns teaching on creationism and ID to religious education lessons: '*Teachers of subjects such as RE, history or citizenship may deal with creationism and intelligent design in their lessons. If such issues were to arise there might be value in science colleagues working with these teachers in addressing them.'*

Note from the above that even outside science lessons, creationism and ID are considered to be optional. This implies that their contribution should be by-passed rather than confronted and critiqued. The need clearly exists to teach a strong and genuine interface between faith and science, since even the most highly-regarded in the scientific world – Richard Dawkins included – do not appear to handle well the relationship between these two branches of knowledge. Scientists who espouse macro evolution often seem to overlook the fact that their own arguments in defence of evolution seem necessarily to degenerate into what we might loosely term a faith position.

In the interests of educational objectivity and sincere and serious inquiry and debate, it is surely essential to teach the faith/science interface in the context of all three views? Surely, we owe it to the nation's children better to equip them to address these challenges by replacing the current

piecemeal and polarised teaching approach with a more open, fair and objective consideration of origins, faith and science?

What can we do?

1 We can press the Department for Children Schools and Families (DCSF) for clarity and justification of the guidance regarding its views on scientific theory and the failure to acknowledge the science of ID and the science associated with creationism.

2 We can press for systematic guidance and good teaching of the relationship between science and faith in the context of origins in place of the current lamentable standards. This shows that people are interested, have spotted the shortcomings and require explanations and guidance that make better sense and which leads to a balanced, more widely informed understanding of the key views on origins. The Department claims that the vast majority of enquiries on this subject have expressed concern over the TiS initiative. If we care then we need to act to seek to redress this imbalance of viewpoints.

3 Write to your local MP asking him or her to forward your views to the DCSF. Through this contact you will learn something of your MP's views on the subject. You may even be able to persuade him or her that the current guidance needs changing and improving.

4 If you are associated with a school in any way, ask them how they propose to present creationism and ID, if they arise. Also ask how they deal with the issue of how science works in the context of origins, referring to the section (quoted above) in the guidance. If their answers are inadequate, then gently point out the problems which the science associated with creationism and ID poses for evolution theory. In particular, indicate the need for a sensible dialogue rather than blindly following the 'evolution is right, everything else is non-scientific rubbish' approach. The TiS website has relevant primers and detail tailored for you and for teachers.

5 Don't let the scientific establishment get away with unsubstantiated assumptions. Write clearly but courteously to the Royal Society, the Science Museum, or *Nature* Magazine, and similar institutions or publications, whenever they appear to be making unscientific assertions, pointing out that such untested positions lack the authority which is being assumed.

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