

# Debating Evolution in Context – Religion in the Biology Classroom

Michael J Reiss

## Abstract

Evolution is perhaps the central theory in biology. Many with a religious faith accept its validity but there are many with a religious faith who reject it, holding that it contradicts their understanding of their religion. I examine the place of religion in the biology classroom when teaching evolution in four contrasting countries: Brazil, England, Pakistan and the USA and then go on to discuss ways in which school biology teachers might deal with the issue. One approach is to consider evolution as a controversial issue; this can work well so long as 'controversial' is used to mean 'contentious', not that evolution is scientifically controversial – the overwhelming majority of scientists see evolution as a very robust and well-established theory. I explore the worth of seeing acceptance of creationism or intelligent design as worldviews, and discuss the advantages of treating evolution as a sensitive issue for some students.

## Key words

Evolution, science and religion, school biology, Brazil, England, Pakistan, the USA, controversial issues, worldviews, sensitive issues

To the surprise of many science educators, the delight of some and the irritation of others, issues to do with religion seem increasingly to be of importance in school science lessons, science museums and some other educational settings for science, such as zoos. In this chapter I look at possible ways in which religion might relate to science, focusing on the topic of evolution, as taught in schools and consider what the implications of religion might be for science education. While the issues apply globally, I focus on four countries: Brazil, England, Pakistan and the USA. I write primarily as a science educator, though with a long-standing interest in religion: I have been an ordained minister in the Church of England for over thirty years and am currently President of the International Society for Science and Religion.

### **The relationship(s) between religion and science**

The possible relationships between religion and science have been thoroughly explored for a number of decades (specialist journals include: *Journal for the Scientific Study of Religion*; *Philosophy, Theology and the Sciences*; *Theology and Science*; and *Zygon*). This preoccupation is presumably a reflection of the fact that these two systems of knowledge and practice are each deeply interested in both the nature of reality and our apprehension of it. The account on the relationship(s) between religion and science that is most often cited in the science-religion field is that of Barbour (1990), even though Barbour himself revised it in Barbour (1997), his account has been critiqued (e.g., Cantor and Kenny 2001) and a number of other authors have either proposed different accounts (e.g., Haught, 1995) or have produced nuanced historical analyses (Brooke 1991; Harrison 2015). It should be stressed that Barbour's focus was primarily that of epistemology (Reiss 2014), whereas there are various other foci through which the relationship(s) between religion and science might be examined, including ethics (e.g., the moral status of the human embryo; end-of-life issues), psychology (e.g., the neurological consequences of meditation) and law (issues to do with divorce; inheritance).

Barbour suggested four possible ways in which religion and science might interrelate. The first he discusses is conflict. This is not the way in which Barbour himself chiefly understands the relationship – Ian Barbour (1923-2013) being with Arthur Peacocke (1924-2006) and John Polkinghorne (1930-2021) one of the three 'founding fathers' of the science-religion field – but it is perhaps the most widely presumed, especially among those with little or no religious faith. Barbour saw limitations in this way of understanding the science-religion issue. As he memorably put it:

In a fight between a boa constrictor and a wart-hog, the victor, whichever it is, swallows the vanquished. In scientific materialism, science swallows religion. In biblical literalism, religion swallows science. The fight can be avoided if they occupy separate territories or if, as I will suggest, they each pursue more appropriate diets.  
(Barbour 1990, p.4)

Barbour's second possible relationship was that of independence. A famous proponent of this way of understanding the relationship was the palaeontologist and popular science communicator, Stephen Jay Gould, who wrote of science and religion as being 'non-

overlapping magisteria', with science being concerned with the factual character of the natural world and religion operating in the realm of human purposes, meanings and values (Gould 1999). In this understanding, science and religion are seen as distinct from the other and enjoy their own autonomy:

Each has its own distinctive domain and its characteristic methods that can be justified on its own terms. Proponents of this view say there are two jurisdictions and each party must keep off the other's turf. Each must tend to its own business and not meddle in the affairs of the others. Each mode of inquiry is selective and has its limitations.

(Barbour 1990, p.10)

Barbour's third relationship was that of dialogue. As an example, Barbour pointed out how our increasing understanding of cosmology has led us to ask why the initial conditions were present that allowed the universe to evolve. The point is not that the findings of science require a religious faith – that would be for the wart-hog of religion to swallow the boa constrictor of science. Rather, the point is that scientific advances can give rise (no claim is made that they do for all people) to religious questions, so that a dialogue ensues.

Barbour's final relationship was that of integration. This understanding of how science and religion relate is probably common to many people with a strong religious faith. It is simply assumed that there is a coherent account of the universe, even if we are not fully able to discern it, and that while science and religion may each be better suited to answering different questions (cf. non-overlapping magisteria), there is no part of human thought or the universe that lies outwith God's compass or care. Examples of academic accounts to explicate religion-science integration include natural theology, process theology and panpsychism.

### **The importance of evolution for science and for religion**

My PhD and post-doc were in evolutionary biology and population genetics, so I might be somewhat partial, but few biologists would disagree with the assertion that *the* theory that binds together all of biology at whatever spatial scale and over whatever time period is evolution. The centrality of evolution to biology is captured in the famous words that the distinguished geneticist and Eastern Orthodox Christian Theodosius Dobzhansky used for the title of an article he wrote for biology teachers towards the end of his life: 'Nothing in Biology Makes Sense Except in the Light of Evolution' (Dobzhansky 1973).

The theory of evolution had been around for a long time but what moved it from being a scientific possibility to the mainstream was when Charles Darwin and Alfred Russel Wallace independently came up with the theory of natural selection as the mechanism to drive evolution. They jointly gave a paper at the Linnean Society in 1858 to announce their theory to the world – though Wallace, who didn't even know about the paper, was on fieldwork in the Moluccas in Indonesia and Darwin, who didn't much like coming up to London, was grieving for his last child, Charles who had died, aged 18 months, three days previously. Although Darwin's great friend Hooker, writing to one of Darwin's sons, Francis, 28 years

after the event, describes how the room was awestruck, the official record of the year, as reviewed by the outgoing President, Thomas Bell in 1859, wonderfully contained the following words:

The year which has passed ... has not, indeed, been marked by any of those striking discoveries which at once revolutionise, so to speak, the department of science on which they bear.

(Marshall 2018)

As with any scientific area, there are parts of evolution that are unclear, where scientists still actively work attempting to discern what is going on or has gone on in nature (examples include the very early history of life on Earth and what drives altruism, when organisms help others). But much of evolution is not like that, being a well-established body of knowledge that has built up over 150 years as a result of the activities of many thousands of scientists. The following are examples of statements about evolution that lack scientific controversy (Reiss 2013):

- All of today's life on Earth is the result of modification by descent from the simplest ancestors over a period of several thousand million years.
- Natural selection is a major driving force behind evolution.
- Evolution relies on those occasional instances of the inheritance of genetic information that help (rather than hinder) its possessor to be more likely to survive and reproduce.
- Most inheritance is vertical (from parents) though some is horizontal (e.g., as a result of viral infection carrying genetic material from one species to another).
- The evolutionary forces that gave rise to humans do not differ in kind from those that gave rise to any other species.

For those who accept such statements and the theory of evolution, there is much about the theory of evolution that is intellectually attractive. Perhaps above all, the one theory provides a way of explaining a tremendous range of observations; for example, why it is that there are no rabbits in the Precambrian ('rabbits in the Precambrian' being one of the geneticist's J B S Haldane's answers to the question of what would destroy his confidence in the theory of evolution), why there are many superficial parallels between marsupial and placental mammals, why monogamy is more common in birds than in fish and why what look like whales with legs are found in the fossil record. More practically, the theory of evolution is being used in a number of ways to help understand what are otherwise surprising phenomena in medicine (see, for example, Nesse and Williams (1996) and articles in the journal *Evolution, Medicine & Public Health*), such as the disadvantages of living in too clean an environment (which can trigger autoimmune problems) and the prevalence of Attention Deficit Hyperactivity Disorder (Swanepoel et al. 2017).

The theory of evolution is important for religion too as, depending on the religion and the views of religious believers, the relationship of evolution and religion can, using Barbour's terminology above, be one of conflict, independence, dialogue or integration. Of these possibilities, the phenomena of creationism and intelligent design fit squarely within the conflict camp.

Creationism exists in a number of different forms but in countries where surveys have been undertaken between about 5% of adults in the Nordic countries and Japan and 50% of adults in Turkey (40% in the USA, as discussed below) reject the theory of evolution and believe that the Earth came into existence as described by a literal (i.e. fundamentalist) reading of the early parts of the Bible or the Qur'an and that the most that evolution has done is to change species into closely related species (Miller et al. 2006; Lawes 2009). Christian fundamentalists generally hold that the Earth is nothing like as old as evolutionary biologists and geologists conclude – as young as 10,000 years or so for young-Earth creationists. For Muslims, the age of the Earth is much less of an issue.

Allied to creationism is the theory of intelligent design. While many of those who advocate intelligent design have been involved in the creationism movement, to the extent that the US courts have argued that the country's First Amendment separation of religion and the State precludes its teaching in public schools (Moore 2007), intelligent design can claim to be a theory that simply critiques aspects of evolutionary biology rather than advocating or requiring religious faith. Those who promote intelligent design typically come from a conservative faith-based position (though there are atheists who accept intelligent design). However, in their arguments against evolution, they typically make no reference to the scriptures or a deity but argue that the intricacy of what we see in the natural world, including at a sub-cellular level, provides strong evidence for the existence of an intelligence behind this (e.g., Meyer 2009). An undirected process, such as natural selection, is held to be incapable of explaining all such intricacy.

### **The place of religion in the biology classroom**

To many science educators, especially those of an agnostic/atheistic persuasion, even raising the possibility that religion might be considered in some way within science education raises suspicions that this is an attempt to find a way of getting religion into the science classroom for religious rather than scientific or educational reasons. In terms of the nature of science, part of the argument for addressing religion in the science classroom is that considering religion can, on occasions, be useful in helping learners better understand why certain things come under the purview of science and others don't (Reiss 2008a).

Another argument for considering religion within science lessons proceeds much as an argument for considering history in science lessons might. While science can be learnt and studied in an historical vacuum, there are reasons why it can be helpful to study science in its historical contexts. For a start, this helps one understand better why certain sorts of science were pursued at certain times. Then there is the observation that for many learners understanding science in historical contexts can aid motivation. Science courses that take contexts and applications into account are now quite widespread.

Similarly, while many students enjoy learning about the pure science of genetics and evolution, others are motivated *and* may come to understand the science better if they appreciate something of the diversity of religious beliefs held by such principal protagonists as Charles Darwin, Joseph Hooker, Thomas Huxley and Gregor Mendel and the religious

views (including the diversity of religious views) of the cultures in which they lived and worked.

More generally, there are a number of places where religion and science interact and the topic of evolution is a cause célèbre. Part of the purpose of school science lessons is to introduce students to the main conclusions of science, and the theory of evolution is one of these. This raises a number of general questions that I will address. First, though, I examine the place of religion in the biology classroom when teaching evolution in four contrasting countries: Brazil, England, Pakistan and the USA.

## **Brazil**

Brazil is a country characterised by a high level of religious affiliation, principally Catholic (since colonisation) but with rapidly expanding Protestant and Pentecostal movements. Pentecostal churches have grown very substantially since the 1970s, especially in poor areas which lack basic state services, such as satisfactory education, health and basic sanitation. Over the same period, there has been a growth in creationist publications and groups, like the Brazilian Creationist Society and the Brazilian Association for Creation Research (Teixera 2019). Pentecostal denominations have shown a rising resistance towards evolution theory, especially through the publication of books and other materials and by trying to pass legislative bills for introducing creationism in public and private schools. A national survey showed that evolution is accepted by slightly more than half of the population (54%), but that the overwhelming majority of Brazilians (89%) believe that creationism should be taught in schools (Brum et al. 2005 cited in Oliveira and Cook 2018).

Cruz (2020) provides an account of science and religion in schools in Brazil (see also Oliveira and Cook 2018). Schooling in Brazil is fairly homogeneous across its 27 states. Most schools are state-run (some are related to the state government, others related to the municipalities), though there are also a considerable number of private schools. Most of the private schools are confessional and Roman Catholic; a few are evangelical (Lutheran, Presbyterian, Baptist, Adventist, etc.) or Jewish. Creationism is most entrenched in the evangelical schools, but even here, the schools usually serve students with a plurality of religious (or nonreligious) backgrounds, so they must display a broadly tolerant view if they wish to fill their classrooms.

Religious education in these confessional schools follows different models, according to the mission of each one. For example, 'The Holy Cross' in São Paulo (run by the congregation of the same name) is a fairly liberal Roman Catholic School. As the schools' website puts it:

Religious education is offered to all students and it is integral to the curriculum, beginning in the 2<sup>nd</sup> grade and ending in the 9<sup>th</sup> grade. There are weekly classes, which enable students to examine religious phenomena openly, and in a coherent and engaged way. For that purpose, the student learns about different religious traditions, experiences human values, develops the potential for a spiritual experience and is encouraged to practice solidarity.

(Colégio Santa Cruz 2022)

Reading through the curricula in this school in both the sciences and in religious education, any science and religion topics are conspicuous by their absence. The same seems to be true in other confessional schools. Textbooks and other materials are equally meagre in content related to science and religion.

Brazil also has provision for religious education in its public schools. The school must be open to including religious education in the curriculum (from the 5<sup>th</sup> to the 9<sup>th</sup> grade), but it is not mandatory for students. Moreover, it must be non-confessional and respectful of the secular state, something that has generated heated discussion about content and teacher credentials (Cruz 2020). For some school officials, religious education is too much trouble, so they do not make any effort to comply with the legal requirements. Secular critics of the system always point out the threat of proselytism and, to a lesser extent, of teaching creationism. On the other hand, there are many concerned people, usually Christians, who have developed non-confessional curricula for religious education classes in these schools.

All in all, Cruz (2020) concludes that it is difficult to engage in science-and-religion issues in state-run schools. There are a fair number of science-and-religion books and articles on the market, both translated from foreign authors, such as John Polkinghorne, Alister McGrath and Ian Barbour, and written by Brazilians. However, these materials are not well known outside small circles, and they have not been translated into textbooks or other formats for school students. Moreover, most teachers, either in the sciences or in religious education, are not sufficiently well prepared to understand the issues at stake.

There is now a growing literature on the intersection of biology and religion in Brazilian schools. Teixeira (2019) investigated the acceptance of evolution and creationism by high school students in Rio de Janeiro. Two indices were created: (i) Acceptance of the Scientific Aspects of Evolution Factor (SA); and (ii) Acceptance of the Biblical Narrative for the Origin and Development of Living Beings Factor (BN). Unsurprisingly, the findings showed that Pentecostal students had a lower mean for SA and greater for BN in comparison to other religious groups.

Penteado et al. (2012) had previously shown that when it comes to those beginning their undergraduate studies in their case study university in Brazil, which typically happens at age 18, the majority of students taking science courses answered 'Yes' rather than 'No' in response to the question whether 'Creationism should be taught in the science classes as an alternative to the evolutionary theory?'. Furthermore, 78% of the 231 students self-identified as Catholic compared to only 9% as evangelical – so this support of creationist teaching is not the result of large numbers of evangelical students.

Looking to the future, it seems likely that the influence of creationism and intelligent design will grow in both schools and universities. However, in contradistinction to the USA (considered below), the state has a strong hand in the public school system with regards both to curricula and to teaching practices, so it may be unlikely that creationism will be formally taught there (Cruz 2020). On the other hand, the number of teachers with an evangelical background is growing, so it seems premature to predict with any confidence what will happen.

## England

Charles Darwin lived all his life in England, except for the five formative years he spent as a young man on *HMS Beagle*, and his *On the Origin of Species* was first published in England in 1859. While not all elements of Victorian society were pleased to hear of Darwin's ideas, these ideas met, to the surprise of some, with broad acceptance in the Church of England and elsewhere. This was in no small measure because of the care Darwin himself took to try to minimise any conflict with religion or the social conventions of the time (cf. Browne 2002).

Darwin's ideas led to two main theological responses in England (Reiss 2018a). The minority theological response was the one that eventually helped give rise to today's creationism. Perhaps the most ingenious and infamous manifestation of this response was that of Philip Henry Gosse. In addition to being an outstanding naturalist (he was elected a Fellow of the Royal Society in 1856), Gosse had a deep religious faith and when he published *Omphalos: An Attempt to Untie the Geological Knot* in 1857, just two years before Darwin's *Origin*, he coined what has become known as the 'Omphalos hypothesis'.

The Omphalos hypothesis is an attempt to combine a serious reading of the fossil record – which suggests a huge expanse of time before any possible Garden of Eden (with its human inhabitants) – and a literal reading of the Bible. *Omphalos* is Greek for navel and Gosse began by wondering whether Adam had a navel (despite, in this literal reading of scripture, having not been attached by an umbilical cord to his mother, given that he was created directly by God from the dust of the Earth). Gosse supposed that Adam did have such a navel (he was a 'normal' human being), just as the trees in the Garden of Eden were presumably created with tree rings. Can you see where the argument is going? Just as Adam had a navel and the trees in the Garden of Eden their tree rings, perhaps the rocks created during the days of creation carried within them the entire fossil record. Despite the internal logic of Gosse's argument, the critics reacted badly. Charles Kingsley (not only the author of *The Water-Babies*, but also a university professor and a priest) wrote that he could not believe that God had "written on the rocks one enormous and superfluous lie for all mankind".

The majority theological approach to Darwin's ideas was a positive one. The large amount of evidence, the logic of its argument, and the care Darwin took to avoid theological confrontation were crucial in the quite rapid Victorian acceptance of evolutionary thinking. The same Charles Kingsley read a pre-publication copy of *The Origin* and wrote to Darwin: "I have gradually learnt to see that it is just as noble a conception of Deity, to believe that he created primal forms capable of self development into all forms needful *pro tempore & pro loco*, as to believe that He required a fresh act of intervention to supply the *lacunas wh.* he himself had made".

There have been a number of surveys that have attempted to quantify public acceptance of evolutionary thinking in England (Reiss 2018a). Although different surveys often use slightly different wording (McCain and Kampourakis 2018), which it difficult to make both



international comparisons and to track changes over time, it is generally agreed that England is a country with a high acceptance of evolutionary theory (Miller et al. 2006), though it also has a widespread toleration of creationism and intelligent design (Spencer and Alexander 2009).

England has a strong tradition of religious education in schools, with religion typically not being considered in science lessons. Until about the year 2000, evolution was a relatively uncontested area of the school curriculum in England. It occupied a core but fairly modest place within secondary school biology (for 11-18 year-olds) and was also often considered within religious education lessons in the context of the relationship between science and religion. However, the rise of creationism in England – due partly to immigration, including from Muslim families, and partly to an increasing polarisation within mainstream Christianity with a growth in fundamentalism – has contributed to change this.

In the summer of 2007, after months of behind-the-scenes meetings and discussions, the DCSF (Department of Children, Schools and Families) *Guidance on Creationism and Intelligent Design* received Ministerial approval and was published (DCSF 2007). The Guidance pointed out that the use of the word ‘theory’ in science (as in ‘the theory of evolution’) can mislead those not familiar with science as a subject discipline because it is different from the everyday meaning (i.e., of being little more than an idea). In science the word indicates that there is a substantial amount of supporting evidence, underpinned by principles and explanations accepted by the international scientific community. The Guidance went on to state:

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. (DCSF 2007)

The Guidance pointed out that the nature of, and evidence for, evolution must be taught at key stage 4 (14-16 year-olds) as these topics are part of the programme of study for science, while key stages 1 (5-7 year-olds), 2 (7-11 year-olds) and 3 (11-14 year-olds) include topics such as variation, classification and inheritance that lay the foundations for developing an understanding of evolution at key stage 4 and post-16. It then went on to say:

Creationism and intelligent design are not part of the science National Curriculum programmes of study and should not be taught as science. However, there is a real difference between teaching ‘x’ and teaching *about* ‘x’. 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. (DCSF 2007)

The Labour (1997-2010), Coalition (2010-15) and Conservative (2015-present) governments in the UK have been consistent in their support for evolution as occupying a key and mandatory place in the school science curriculum. The current version of the science

curriculum has included evolution at primary level (5-11 year-olds) since 2014 and this is reflected in the greater emphasis currently being given to evolution education in the education of those training to become primary teachers (Billingsley et al. 2019; Russell and McGuigan 2019). However, successful teaching of evolution in primary schools is hampered by the fact that the large majority of primary teachers have learnt no biology at school after the age of 16 years-old, and by political moves since 2010 to reduce the involvement of universities in initial teacher education and the continuing professional development of teachers.

## **Pakistan**

Pakistan was created in 1947 as an independent nation for Muslims from the regions in the east and west of the (Indian) subcontinent where there was a Muslim majority, as a result of the Pakistan Movement led by Muhammad Ali Jinnah and the subcontinent's struggle for independence (ARDA 2022). Initially a dominion, Pakistan adopted a new constitution in 1956, becoming an Islamic republic (Article 2 of the 2017 version of the Constitution). A civil war in 1971 resulted in the secession of East Pakistan as the new country of Bangladesh. Today, about 95% of the country identifies as Muslim, mostly Sunni. Religious education is largely mandatory in schools, though there are sometimes non-religious alternatives that focus on ethics or philosophy more generally.

Asghar et al. (2010) provide a comprehensive account of the place of evolution in public school education in Pakistan. Pakistan has a centralised public education system; the Ministry of Education is responsible for developing education policies, and the national curricula are designed by the Curriculum Wing of the Ministry. The provincial textbook boards produce the textbooks for various subjects in accordance with guidelines set up by the Curriculum Wing.

In their analysis, Asghar et al. (2010) “found that Islamic beliefs and Quranic scripture are interwoven with scientific content in the public school biology curriculum and textbooks in Pakistan” (p.67). Indeed, Pakistan’s National Curriculum for biology at grades 9-12 states that the primary goal of biology education is to “enable the students to appreciate that Allah (SWT) is Creator and Sustainer of the universe”.

Asghar et al. (2010) found that school biology textbooks present both religious and scientific perspectives in their treatment of the origin of life and evolution. Biology textbooks have section titles that include ‘Quranic teachings about animals and plants’, ‘Islamic view about the origin of life’ and ‘Living world in the light of Islamic thought’. Evolutionary topics presented include the history of the development of scientific theories related to the chemical and organic evolution of life, evolution from prokaryotes to eukaryotes, neo-Darwinism and the modern synthesis, artificial selection and population genetics.

Typically, material is presented in a way that attempts to reconcile a straightforward (literal) interpretation of scripture with the mainstream scientific understanding of the origin of life. For example, a grade 12 biology textbook under the heading ‘Nature of Earliest Organisms’ states:

It is believed that life may have begun in water especially in hot springs called hydrothermal vents. The Holy Quran also gives evidence for this event in this Holy verse: ‘Allah hath created every animal of water. Of them is (a kind) that goeth upon its belly and (a kind) that goeth upon two legs and (a kind) that goeth upon four. Allah createth what He will. Lo! Allah is able to do all things. (*Sura Al-Nur, Ayat 45*). These vents could have supplied the energy and raw material for the origin and survival of early life forms.

(Sindh Textbook Board 2006, p.221)

As Asghar et al. (2010) point out: “This interpretation of scripture seems to indicate an association between the religious concept of the beginning of life in water, the scientific evidence suggesting that the first life on Earth arose in its oceans, and the evolutionary inference of the relationship between all living organisms through common ancestry” (p.68). This consonance of scripture and mainstream evolutionary theory was also found in the particularly contentious question of human origins. For instance, a grade 9 textbook states:

Therefore, it seems that there were two big steps as far as the creation of man was concerned. The first step was the creation from water. The second step was whereby the first created thing, on admixing with clay, was transformed into more advanced being. The same can also be applied to other animals, because there are certain similarities between the structure of man and other animals. Digestive system, nervous system, circulatory system, and reproductive system are similar although dissimilar in other details.

(Balochistan Textbook Board 2005, pp.13-14)

Although evolution is generally presented positively, Pakistani textbooks often present creationist accounts as an alternative way of understanding biological diversity. For example, a grade 12 textbook states:

In a bid to explain the cause of diversity of life and interrelationship among living organisms, two schools of thought emerged in the earlier 19th century. Creationists believed in the Theory of Special Creation, whereas evolutionists believed in the Theory of Natural Selection.

(Punjab Textbook Board 2003, p.222)

A subsequent study by Asghar et al. (2014) of the status and treatment of evolutionary science in secondary education in Egypt, Malaysia, Syria, Turkey, and Pakistan showed that Pakistan was unusual among these five Muslim-majority countries in that in the other four religious references were rare.

Finally, in a comparative study of Canada and Pakistan, Asghar (2013) undertook individual and group interviews with 25 high school teachers from a total of six schools across the two countries; 18 of these teachers worked in Pakistan (in a total of four schools). Fourteen of the Pakistani teachers either accepted or considered the possibility of the evolution of living organisms. For example, one teacher explained that the idea of the biochemical origin of life

did not conflict with her religious beliefs since “God made everything from water and science also says that life originated in water”. She went on to say:

Inorganic chemicals and minerals turned into organic compounds, and simple life forms originated from these chemicals. Complex eukaryotes evolved from prokaryotes and ... trees and plants and animals developed through evolution.

(Asghar 2013, p.6)

However, nearly all of them rejected the possibility of human evolution. As two interviewees put it:

The Islamic view of human creation is that humans were made with clay and water by God. Then they developed gradually ... Humans were created by Allah with water and clay as they are in their present form, physical structure and form.

Human beings didn't evolve from any other species. Allah created Adam from clay and blew His spirit into him. That's why humans decompose into clay after dying.

(Asghar 2013, p.7)

In Asghar's study, all but one of the Pakistani science teachers were in favour of using religious-based explanations about the creation of life in their science courses.

## The USA

Of the four countries considered in this chapter, the USA is the one where there perhaps is the greatest conflict between religion and mainstream science when it comes to the teaching of school biology (cf. Miller et al. 2022). It remains the case that about 40% of US adults (40% in 2019 compared to 44% in 1983) when asked ‘Which is closest to your view: humans developed from less advanced forms of life, but God guided this process; humans developed from less advanced forms of life, but God had no part in this process; or God created humans in their present form?’ answer ‘God created humans in their present form’ (Gallup 2022). This figure is very high for a Western democracy, though it should be noted that from 1983 to 2019 the percentage of those answering ‘humans developed from less advanced forms of life, but God had no part in this process’ has increased from 9% to 22%. Slightly more than a half of college biology students hold that evolution is atheistic even when given the option to choose an agnostic perception of evolution (Barnes et al. 2020).

The USA is also unusual in that its 13,000 school districts have a significant degree of autonomy with respect to curriculum and instruction. However, school districts are constrained by the constitutional separation between church and state, and a tradition in which there is therefore almost no teaching about religion in the public school system, beyond the occasional treatment in history or social studies (Hess 2011). Furthermore, there are very significant geographical differences in the typical attitudes of parents and those who run schools to the question of evolution. As Hess (2011) puts it:

In some regions, state legislatures tilt in a more conservative direction, and periodically attempt to permit the inclusion within the curriculum of alternative explanations to evolution. Constituents in other school districts – particularly in states with strong citizen groups supporting science – are quite vigilant about watching for religious influences creeping into public school science instruction.

Private schools in the United States enjoy greater curricular flexibility. Some private schools – particularly those in the Roman Catholic tradition – take a scholarly approach but fundamentalist Christian schools often present young-Earth creationism rather than evolution, as does much of the home-school movement. The Christian schools movement in the USA, which has roots in the 1920s but proliferated in the 1960s and 1970s, was led by fundamentalist educators. Supreme Court decisions ending state-mandated prayer and bible reading, along with fears over the teaching of evolution, spurred their formation. In addition, negative reactions to the desegregation of public schools undoubtedly motivated the founding of at least some of these schools (Johnson, 2011; Laats, 2009).

The biology teaching materials used in most fundamentalist schools are not ones that most biology educators would consider appropriate. In addition to their omission or denigration of evolution, they are often of poor educational quality more generally (Scaramanga and Reiss 2017) and contain material that perpetuates white supremacy (Scaramanga and Reiss 2018).

There is a long history of arguments in the USA over the place of evolution in schools ending up in the courts, with the first legislative vote to ban the teaching of evolution occurring in 1922 in Kentucky, just weeks after a Kentucky teacher was fired for teaching that the Earth is round (Moore 2007). The notorious Scopes trial took place in 1925 in Dayton, Tennessee and court battles continue to this day. Moore (2007) provides a helpful guide to a range of questions that the US courts have addressed:

- ‘If a student claims that evolution offends and is incompatible with their religious beliefs, must teachers modify their teaching to accommodate the student’s right to religious freedom?’ The answer is ‘No’.
- ‘Can science teachers teach creationism if their school district adopts a course textbook that promotes creationism?’ The answer is ‘No’.
- ‘Must science teachers who teach evolution give “equal time” to creationism?’ The answer is ‘No’.
- ‘Does “creation science” count as science?’ The answer is ‘No’.
- ‘All citizens of the US have a First Amendment right to free speech. Doesn’t this right to free speech entitle teachers to teach creationism in science classes of public schools?’ The answer is ‘No’.
- ‘Can a school district force a science teacher to stop teaching creationism? If the teacher refuses to teach evolution, can the teacher be reassigned?’ The answer is ‘Yes’.

To date, as Moore (2007) points out, those advocating the teaching of creationism or intelligent design in US public schools have lost every legal challenge.

An early and highly cited account of how to manage the conflict between evolution and religion in US schools was provided by the science educators David Jackson and Lee Meadows in Jackson et al. (1995). That article details the changes in Jackson as he learned how a different set of life experiences can deeply impact science teachers' approaches to evolution in the classroom. Jackson, an agnostic, had never worked with science teachers who also had a deep faith until he moved to Georgia (Meadows 2007). He was surprised to find some school science teachers who were staunchly opposed to teaching evolution to their students. At first, Jackson tried to correct their beliefs about evolution, but then he acknowledged the importance of first listening to them before trying to influence them. When Jackson did so, he began to appreciate that, rather than being uninformed, many of these teachers were very informed about evolution and about religion and were thinking through the relationship between the two. Jackson began to acknowledge that science teachers had to consider the hearts, as well as the minds, of their students – hence the title of the 1995 article: 'Hearts and Minds in the Science Classroom: The Education of a Confirmed Evolutionist'.

### **Dealing with religion in the biology classroom when teaching evolution**

How then might biology teachers deal with the issue of religion when teaching evolution? I have already suggested above some specific suggestions for England and the US. One general approach is to consider evolution as a controversial issue. The advantage of this approach is that there exists a large literature as to how controversial issues might be school science (e.g., Levinson 2006; Reiss 2022). It is important to emphasise that if evolution is considered as a controversial issue, the word 'controversial' is being used in its everyday sense of 'contentious'. I am not maintaining that evolution is scientifically controversial – the overwhelming majority of scientists see evolution as a very robust and well-established theory. Of course, as with any scientific theory, there is much that we do not know and scientists disagree about many specific issues to do with evolution (the level at which natural selection operates – genes, individuals or groups – is a notorious example). However, what almost no scientists question is whether evolution has taken place or not.

One approach to the science-religion issue that has become prominent within science education and is of considerable pedagogical value is focused on the concept of worldviews. The essence of a worldview, as the word itself implies, is that it is a way of conceiving and understanding the world in which one lives. So, someone with a traditional Christian worldview is likely to believe that the world is fundamentally good, having been created by God, but has become corrupted as a result of human sin. For such a person, there is always the hope of redemption and one of the tasks of Christians is to live their lives so as to help bring about the kingdom of God. On the other hand, someone with an atheistic worldview is likely to believe that the world is morally neutral and that there are no ultimate purposes in life beyond those that we decide for ourselves (Reiss 2018b).

The rejection of the theory of evolution on religious grounds is not a simple misconception that careful science teaching can straightforwardly correct, as careful science teaching might hope to persuade a student that an object continues at uniform velocity unless acted on by a net force, or that most of the dry mass of a growing plant comes from air as opposed to

the soil. Rather, a student who believes in the validity of creationism or intelligent design can be seen as inhabiting a non-scientific worldview, a very different way of seeing the world compared to the scientific perspective. The pedagogical significance of this comes largely from the observation that one very rarely changes one's worldview as a result of one or two lessons, however well taught, whereas one may indeed replace a misconception with its scientifically validated alternative after such a brief teaching sequence (Reiss, 2008b).

A student is likely to have far more of personal significance invested in a religious worldview than a scientific misconception. It is clear that the personal implications of abandoning a belief in a literal reading of scriptures that address issues to do with creation are far greater than those of discarding a presumption that objects naturally slow down. Furthermore, many scientific misconceptions are relatively discrete, whereas accepting the theory of evolution and rejecting young-Earth creationism entails accepting the notion of Deep Time, the relatedness of all life, and that God acts in substantially different ways to how one has previously supposed.

I would argue that the aim of including religion in school science lessons, as appropriate, should not primarily be to teach about religion but to enable richer and more effective ways to enable students to understand certain ideas within science and to help them appreciate better certain topics where science and religion interact (Reiss 2008a). If science teachers do deal with religious issues, there is much to be said for them being both true to science and respectful of their students, irrespective of their students' religious beliefs. Indeed, nothing pedagogically is to be gained by denigrating or ridiculing students.

In many countries it is generally unwise for science teachers to get into theological discussions, for example about the interpretation of scripture. Few science teachers have expertise in such matters, whereas they do have expertise in the teaching of science. If they do have one or more students who are articulate, able and willing to present any of the various creationist or intelligent design arguments against the scientific evidence for evolution (e.g., that the theory of evolution contradicts the second law of thermodynamics, that radioactive dating techniques make unwarranted assumptions about the constancy of decay rates, that humans and dinosaurs coexisted in the fossil record, that cells are too complicated to have evolved by natural selection), science teachers can use such contributions to prompt the rest of the class to think rigorously and critically about the arguments and standard accounts of the evidence for evolution.

Finally, there is much to be said for teachers bearing in mind that for some students, evolution, creationism and intelligent design are likely to be sensitive issues (Reiss 2019). Death, sexuality, drugs policy and animal experimentation are other examples of issues that are sensitive for many students, and one advantage of thinking of evolution as a sensitive issue is that teachers are generally used to relating respectfully to students when dealing with sensitive issues. One can be sensitive to someone in respect of an issue without implying that one shares the same perspective (or worldview) as they do.

Bertka et al. (2019) developed a Cultural and Religious Sensitivity (CRS) Teaching Strategies Resource to aid teachers in acknowledging students' religious and cultural concerns about evolution. They reported that "Benefits of participating in these activities noted by students

included reduced tension around the topic of evolution, a recognition that evolution is not necessarily in conflict with religious belief, and an increased understanding of the cultural context of modern and historical views about evolution” (p.1). Lindsay et al. (2019) report “that giving religious students the opportunity to reconcile their religious beliefs with the theory of evolution under the influence of intentional instruction on the compatibility of belief and evolution can lead to increased evolution acceptance among religious students” (p.1).

In a school science lesson when teaching evolution there is therefore much to be said for teachers allowing students to raise any doubts they have and facilitating a genuine scientific discussion about the issues raised. This does not mean that creationism or intelligent design deserve equal time with evolution, nor does it mean that a science teacher should present creationism or intelligent design as valid alternative to the theory of evolution. If questions about the validity of evolution 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 and how scientific knowledge is built up over time, while always being open to the possibility of refutation and change.

At the same time, teaching about evolution, creationism or intelligent design is often not straightforward. Some students get very heated; others remain silent even if they disagree profoundly with what is said. Science teachers need to respect the concerns of students who do not accept the theory of evolution while still introducing them to it. There is much to be said for aiming to get students to understand rather than necessarily to believe or accept the theory of evolution (Smith & Siegel, 2004; Reiss, 2008b). While it is unlikely that even respectful teaching will help students who have a conflict between science and their religious beliefs to resolve the conflict, good science teaching can help students to manage it – and to learn more science (cf. Long, 2011).

## References

- Asghar, A. (2013), ‘Canadian and Pakistani Muslim teachers’ perceptions of evolutionary science and evolution education’, *Evolution: Education and Outreach*, 6 (1): 1–12.
- Asghar, A., Hameed, S. and Farahani, N. K. (2014). ‘Evolution in Biology Textbooks: A Comparative Analysis of 5 Muslim Countries’, *Religion & Education*, 41 (1): 1–15.
- Asghar, A., Wiles, J. R. and Alters, B. (2010), ‘The Origin and Evolution of Life in Pakistani High School Biology’, *Journal of Biological Education*, 44 (2): 65–71.
- ARDA (Association of Religion Data Archives) (2022), *Pakistan*, [https://www.thearda.com/internationalData/countries/Country\\_172\\_1.asp](https://www.thearda.com/internationalData/countries/Country_172_1.asp).
- Balochistan Textbook Board (2005), *Biology 9*, Quetta: Bookland Quetta.
- Barbour, I. G. (1990), *Religion in an Age of Science: The Gifford Lectures 1989-1991, Volume 1*, London: SCM.
- Barbour, I. G. (1997), *Religion and Science: Historical and Contemporary Issues*, London: HarperCollins.
- Barnes, M. E., Dunlop, H. M., Sinatra, G. M., Hendrix, T. M., Zheng, Y. and Brownell, S. E. (2020), “‘Accepting Evolution Means You Can’t Believe in God’: Atheistic Perceptions



- of Evolution among College Biology Students', *CBE – Life Sciences Education*, 19 (2): ar21.
- Bertka, C. M., Pobiner, B., Beardsley, P. and Watson, W. A. (2019), 'Acknowledging Students' Concerns about Evolution: A Proactive Teaching Strategy', *Evolution: Education and Outreach*, 12 (1): 1–28.
- Billingsley, B., Abedin, M., Chappell K. and Hatcher, C. (2019), 'Developing a Cross-Curricular Session about Evolution for Initial Teacher Education: Findings from a Small-Scale Study with Pre-service Primary School Teacher', in U. Harms and M. J. Reiss (eds), *Implementing and Researching Evolution Education: Understanding what Works*, 41–57, Cham: Springer.
- Brooke, J. H. (1991), *Science and Religion: Some Historical Perspectives*, Cambridge: Cambridge University Press.
- Browne, E. J. (2002), *Charles Darwin: Vol. 2. The Power of Place*, London: Jonathan Cape.
- Cantor, G. and Kenny, C. (2001), 'Barbour's Fourfold Way: Problems with His Taxonomy of Science-religion Relationships', *Zygon*, 36: 765–81.
- Colégio Santa Cruz (2022), *Educação Religiosa*, <https://santacruz.g12.br/pastoral-social/educacao-religiosa/>.
- Cruz, E. (2020), *Statement on Science and Religion in Schools in Brazil*, <http://www.iasrs.net>.
- DCSF (2007), *Guidance on Creationism and Intelligent Design*, <http://webarchive.nationalarchives.gov.uk/20071204131026/http://www.teachernet.gov.uk/docbank/index.cfm?id=11890>.
- Dobzhansky, T. (1973), 'Nothing in Biology Makes Sense Except in the Light of Evolution', *American Biology Teacher*, 35 (3): 125–9.
- Gallup (2022), *Evolution, Creationism, Intelligent Design*, <https://news.gallup.com/poll/21814/evolution-creationism-intelligent-design.aspx>.
- Gould, S. J. (1999), *Rocks of Ages: Science and Religion in the Fullness of Life*, New York: Ballantine.
- Harrison, P. (2015), *The Territories of Science and Religion*, Chicago: University of Chicago Press.
- Haight, J. F. (1995), *Science and Religion: From Conflict to Conversation*, Mahway NJ: Paulist Press.
- Hess, P. M. J. (2011), *Statement on Science and Religion in Schools in the United States*, <http://www.iasrs.net>.
- Jackson, D. F., Doster, E. C., Meadows, L. and Wood, T. (1995), 'Hearts and Minds in the Science Classroom: The Education of a Confirmed Evolutionist', *Journal of Research in Science Teaching*, 32: 585–611.
- Johnson, O. (2011), 'The Story of Bob Jones University v. United States: Race, Religion, and Congress' Extraordinary Acquiescence', in Eskridge, W. N., Frickey, P. N. and Garrett, E. (eds), 127–165, New York: Thomson Reuters/Foundation Press.
- Laats, A. (2009), 'Christian Day Schools and the Transformation of Conservative Evangelical Protestant Educational Activism, 1962-1990', in D. Meyers and B. Miller (eds), *Inequity in Education*, pp. 183–210. Plymouth: Lexington.
- Lawes, C. (2009), *Faith and Darwin: Harmony, Conflict, or Confusion?* London: Theos.
- Levinson, R. (2006), 'Towards a Theoretical Framework for Teaching Controversial Socio-scientific issues', *International Journal of Science Education*, 28 (10): 1201–24.

- Lindsay, J., Arok, A., Bybee, S. M., Cho, W., Cordero, A. M., Ferguson, D. G., ... and Jensen, J. L. (2019), 'Using a Reconciliation Module Leads to Large Gains in Evolution Acceptance', *CBE – Life Sciences Education*, 18 (4): ar58.
- Long, D. (2011), *Evolution and Religion in American Education: An Ethnography*. Dordrecht: Springer.
- McCain, K. and Kampourakis, K. (2018), 'Which Question do Polls about Evolution and Belief Really Ask, and Why Does it Matter?', *Public Understanding of Science*, 27 (1): 2–10.
- Marshall, E. (2018), '160th Anniversary of the Presentation of "On the Tendency of Species to Form Varieties"', *The Linnean Society of London*, 1 July.  
<https://www.linnean.org/news/2018/07/01/1st-july-2018-160th-anniversary-of-the-presentation-of-on-the-tendency-of-species-to-form-varieties>.
- Meadows L. (2007) 'Approaching the Conflict Between Religion and Evolution', in L. Jones and M. J. Reiss (eds), *Teaching about Scientific Origins: Taking Account of Creationism*, 145–57, New York: Peter Lang.
- Meyer, S. C. (2009), *Signature in the Cell: DNA and the Evidence for Intelligent Design*. New York: HarperCollins.
- Miller, J. D., Scott, E. C. and Okamoto, S. (2006), 'Public Acceptance of Evolution', *Science*, 313: 765–6.
- Miller, J. D., Scott, E. C., Ackerman, M. S., Laspra, B., Branch, G., Polino, C. and Huffaker, J. S. (2022), 'Public Acceptance of Evolution in the United States, 1985–2020', *Public Understanding of Science*, 31 (2): 223–38.
- Moore, R. (2007), 'The History of the Creationism/Evolution Controversy and Likely Future Developments', in L. Jones and M. J. Reiss (eds), *Teaching about Scientific Origins: Taking Account of Creationism*, 11–29, New York: Peter Lang.
- Nesse, R. M. and Williams, G. C. (1996), *Why We Get Sick: The New Science of Darwinian Medicine*, New York: Vintage Books.
- Oliveira, A. W. and Cook, K. L. (2018), 'Evolution Education and the Rise of the Creationist Movement in Brazil', in H. Deniz and L. A. Borgerding (eds), *Evolution Education Around the Globe*, 119–36, Cham: Springer.
- Penteado, P. R., Kavalco, K. F. and Pazza, R. (2012), 'Influence of Sociocultural Factors and Acceptance of Creationism in the Comprehension of Evolutionary Biology in Freshman Brazilian Students', *Evolution Education Outreach*, 5: 589–94.
- Punjab Textbook Board (2003), *Biology XII*, Lahore: Dar Brothers.
- Reiss, M. J. (2008a), 'Should Science Educators Deal with the Science/Religion Issue?', *Studies in Science Education*, 44: 157–86.
- Reiss, M. J. (2008b), 'Teaching Evolution in a Creationist Environment: An Approach based on Worldviews, not Misconceptions', *School Science Review*, 90 (331): 49–56.
- Reiss, M. J. (2013), 'Beliefs and the Value of Evidence', in J. K. Gilbert and S. M. Stocklmayer (eds), *Communication and Engagement with Science and Technology: Issues and Dilemmas*, 148–61, New York: Routledge.
- Reiss, M. J. (2014), 'What Significance does Christianity have for Science Education?', in M. Matthews (ed.), *Handbook of Historical and Philosophical Research in Science Education*, 1637–62, Dordrecht: Springer.
- Reiss, M. J. (2018a), 'Evolution Education in England' in H. Deniz and L. A. Borgerding (eds), *Evolution Education Around the Globe*, 155–67, Dordrecht: Springer.

- Reiss, M. J. (2018b), 'Why a Chapter on Religion in a Book on Science Education?', in L. A. Bryan and K. Tobin (eds), *13 Questions: Reframing Education's Conversation – Science*, 295–311, New York: Peter Lang.
- Reiss, M. J. (2019), 'Evolution Education: Treating Evolution as a Sensitive rather than a Controversial Issue', *Ethics and Education*, 14 (3): 351–66.
- Reiss, M. J. (2022). 'Learning to Teach Controversial Topics', in J. A. Luft and M. G. Jones (eds), *Handbook of Research on Science Teacher Education*, 393–403, New York: Routledge.
- Russell, T. and McGuigan, L. (2019), 'Developmental Progression in Learning About Evolution in the 5–14 Age Range in England', in U. Harms and M. J. Reiss (eds), *Evolution Education Re-considered: Understanding What Works*, 59–80, Cham: Springer.
- Scaramanga, J. and Reiss, M. J. (2017), 'The Suitability of the International Certificate of Christian Education as an Examination for University Entrance', *Oxford Review of Education*, 43 (6): 788–804.
- Scaramanga, J. and Reiss, M. J. (2018), 'Accelerated Christian Education: A Case Study of the Use of Race in Voucher-funded Private Christian Schools', *Journal of Curriculum Studies*, 50 (3): 333–51.
- Sindh Textbook Board (2006), *A Textbook of Biology for Class IX-X Parti*. Jamshoro: Urdu Academy Sindh.
- Smith, M. U. and Siegel, H. (2004), 'Knowing, Believing, and Understanding: What Goals for Science Education?', *Science & Education*, 13: 553–82.
- Spencer, N. and Alexander, D. (2009). *Rescuing Darwin: God and Evolution in Britain Today*, London: Theos.
- Swanepoel, A., Music, G., Launer, J. and Reiss, M. (2017), 'How Evolutionary Thinking can Help us to Understand ADHD', *BJPsych Advances*, 23: 410–8.
- Teixeira, P. (2019), 'Acceptance of the Theory of Evolution by High School Students in Rio de Janeiro, Brazil: Scientific Aspects of Evolution and the Biblical Narrative', *International Journal of Science Education*, 41 (4): 546–66.