my homeschool

Year 10B

Concepts of Modern Western Science

By Jo Lloyd

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Introduction to Parents

Year Ten sees your teenager focus on a range of big concepts and ideas. There is a lot for them to grapple with and seek to understand, with some challenging topics that demand their attention and effort.

One part of the My Homeschool approach to Science in Year Ten is to present students with a range of resources on various topics from different authors in ***The Science Hub***. These resources overview many key concepts of science as well as profiling the scientists themselves. This allows students to gain a better understanding of the men and women behind many of the discoveries that have shaped western science. Charlotte Mason felt that the heroes of science should be the heroes for students, and this is reflected in this approach. Many Christians are leading the way within the sciences, making careful and systematic observations to better understand our world and Creator, and we are pleased to profile them. While some Science courses may present faith and science as potentially opposing views, we know that science doesn't forbid one from coming to Christ. Rather, science is a tool to show and share the material world and seeks to help us better understand it.

In her day, Charlotte Mason was very conscious of the need for knowledge to be progressive. She acknowledged that what might be taught in her schools could be found to be in error in the future due to the advancement of science. She lived in the Victorian era when many were embracing Darwinism and teleological evolution and encouraged students to keep up to date with the latest scholarly articles to be informed. She also realised that such advancements would lead to new conclusions and, because of this, felt that the reverence of science be kept for students:

> *To perceive that knowledge is* progressive, *and that the next 'find' may always alter the bearings of what went before; that we are waiting, and may have very long to wait, for the last word; that science also is 'revelation', though we are not yet able fully to interpret what we know; and that 'science' herself contains the promise of great impetus to the spiritual life – to perceive these things is to be able to rejoice in all truth and to wait for final certainty.*

Believing that God's Word was true, Charlotte felt that scientific advancements would confirm it somehow, and that science would never really be "finished" or "final", but rather another progression and discovery would continue to extend and inform this body of work and investigation.

It is reverence for God and for science, along with an openness of mind and willingness to learn about new and modern progressions in science that ***Concepts of Modern Western Science*** has been developed. It encourages students to learn the theories and concepts included within the Australian Curriculum and NESA Syllabus for students of this age, but to also see these within the broader context of science as an endeavour. In doing this, your teenager is presented with a wide variety of science writing from many different scientists and authors, allowing them to learn from a range of wise, talented, and experienced teachers.

Combined with the profiles of modern scientists in ***The Science Hub***, ***Concepts of Modern Western Science*** encourages your student to be well informed and equipped and to give science their best attention, as well as gratitude and joy, as they seek to learn more about our world and what we are still to discover. This resource is taught throughout Semester Two, with one lesson scheduled per week. Please direct your teenager to:

1. Read the lesson provided, which offers an extract of modern science writing and introductory contextual information for the piece, and then
2. Prepare a Science Notebook entry on that reading, sharing what they learned, noting that some lessons include additional, supplementary information in the Complementary Links.

Complementing both ***The Science Hub*** and ***Concepts of Modern Western Science*** are the Living Books scheduled within the Weekly Planner that focus on the field of physics. The first book this semester, allocated for Term 3 and part of Term 4, is *Storm in a Teacup* by Helen Czerski. During Term 4 *Six Easy Pieces* by Richard P. Feynman is the book to read.

Another alternative would be to read *Botany in a Day* by Thomas J. Elpel, swapping out one physics title for botany if that is a field of science your teenager is keen to learn more about.

This integrated approach to teaching science instructs them in many concepts and theories of modern science, while also pointing to the advancements continually being made, highlighting the progression of knowledge and creativity in this field. My hope is that it may foster interest, skillfully instruct, encourage excitement, and spark a life-long interest in the sciences for them!

Jo Lloyd

Welcome to Students

During Semester One of Year Ten, the focus in Science was on Earth and Space Sciences and Chemistry. This semester we switch to Biology and Physics in the readings within ***The Science Hub*** and the books allocated in the Weekly Planner for Semester Two. Within ***The Science Hub*** you will find information and profiles on the scientists that have contributed to these advances, learning what has inspired and encouraged them and what they have helped us to better understand. Complementing this will be two Living Books to enjoy, allocated within your Weekly Planner. The focus of these books is on physics, though a possible botany option has also been suggested to parents for those who are keen to know more about this field of biology. Complementing this work is also reading about the concepts, theories and discoveries that have defined science in the modern and emerging eras: the purpose of this resource.

Once a week for Semester Two you will complete a lesson from ***Concepts of Modern Western Science***. Simply read the lesson provided here, look at the Complementary Links where provided, and then share what you have learned by completing a Science Notebook entry.

As you work through the lessons, please consider what scientific knowledge existed at the time the relevant piece was written and thus, what the scientists didn't yet know. This helps you to appreciate just what a breakthrough many of these discoveries and theories were. Also, realise that oftentimes an idea or concept would be presented and it wouldn't be embraced to begin with, as scientists worked to determine how this new information and perspective fitted in with what they already knew. Sometimes this takes time. Galileo Galilei's astronomical discoveries and theories of the 16th and 17th Centuries saw him convicted of heresy because he declared that the earth revolved around the sun, yet it wasn't until in 1992 that Pope John Paul II acknowledged the errors made by the Catholic Church in relation to this case, as his heliocentric views were confirmed over time.

I trust you will enjoy this journey through some of the discoveries and theories of modern science and that it offers you an opportunity to ensure you understand these concepts that found our current understanding. For some of you, it may spark an interest and life-long pursuit in the sciences as you become a hero of modern science that others will read about in the future.

Lesson 9 – Biochemistry and Intelligent Design

Overview

While increased knowledge about biochemistry has helped modern science in genetic engineering (as examined in Lesson 8), it has also added to the body of knowledge beyond Darwinism and neo-Darwinism. These new advances encouraged Michael J Behe, a Professor of Biological Science at Lehigh University, in Pennsylvania, in the United States of America, to add his voice to the debate around evolution and natural selection. In 1996 he published *Darwin's Black Box: The Biochemical Challenge to Evolution,* which helped to launch the intelligent design movement. This sought to move beyond the randomness and seeming indifference exhibited by nature as suggested by Darwin and neo-Darwinists, such as Richard Dawkins who, in *River out of Eden* © 1995 wrote:

Nature is not cruel, only pitilessly indifferent. This is one of the hardest lessons for humans to learn. We cannot admit that things might be neither good nor evil, neither cruel nor kind, but simply callous – indifferent to all suffering, lacking all purpose.

Michael J Behe became the leading spokesman for intelligent design, putting forward the view that this was about intentionality, not randomness and cruelty, and offered a viewpoint that living organisms are created by an "intelligent designer". In explaining his title and the concept of a 'black box', Behe writes:

Black box *is a whimsical term for a device that does something, but whose inner workings are mysterious – sometimes because the workings can't be seen, and sometimes because they just aren't comprehensible. Computers are a good example of a black box. Most of us use these marvellous machines without the vaguest idea of how they work, processing words or plotting graphs or playing games in contented ignorance of what is going on underneath the outer case. Even if we were to remove the cover, though, few of us could make heads or tails of the jumble of pieces inside. There is no simple, observable connection between the parts of the computer and the things that it does.*

A devout Catholic and homeschooling dad of nine children, the ultimate black box to Behe is the cell. His perspective is that advances in biochemistry opened the lid on the black box and questioned whether Darwinian evolution is sufficient to explain as we now know it in modern times. As a part of his contribution, Behe developed the concept of 'irreducible complexity'. This is central to the concept of intelligent design and presents the concept that some biological systems cannot have evolved through small modifications through natural selections. It likens Darwinian evolution to a mousetrap that needs multiple parts to work effectively by the definition Behe offers:

…a single system which is composed of several well-matched, interacting parts that contribute to the basic function, and where the removal of any one of the parts causes the system to effectively cease functioning.

Many in the scientific community consider this to be pseudoscience, but Behe asserts that it was developed in response to evolution being unable to explain complex molecular mechanisms and that natural selection through random mutations was impossible; and that the complexity in nature, including incremental changes, is attributed to intentional design.

Selected Reading

The selected excerpt from *Darwin's Black Box: The Biochemical Challenge to Evolution* by Michael J Behe comes from his first chapter, titled "Lilliputian Biology".

Suppose a 4-foot-wide ditch in your backyard, running to the horizon in both directions, separates your property from that of your neighbour's. If one day you met him in your yard and asked how he got there, you would have no reason to doubt the answer, "I jumped over the ditch." If the ditch were 8 feet wide and he gave the same answer, you would be impressed with his athletic ability. If the ditch were 15 feet wide, you might become suspicious and ask him to jump again while you watched; if he declined, pleading a sprained knee, you would harbor your doubts but wouldn't be certain that he was just telling a tale. If the "ditch" were actually a canyon 100 feet wide, however, you would not entertain for a moment the bald assertion that he jumped across.

But suppose your neighbor – a clever man – qualifies the claim. He did not come across in one jump. Rather, he says, in the canyon there were a number of buttes, no more than 10 feet apart from one another; he jumped from one narrowly spaced butte to another to reach your side. Glancing toward the canyon, you tell your neighbor that you see no buttes, just a wide chasm separating your yard from his. He agrees, but explains that it took him years and years to come over. During that time buttes occasionally arose in the chasm, and he progressed as they popped up. After he left a butte it usually eroded pretty quickly and crumbled back into the canyon. Very dubious, but with no easy way to prove him wrong, you change the subject to baseball.

This little story teaches several lessons. First, the word jump *can be offered as an explanation of how someone crossed a barrier, but the explanation can range from completely convincing to totally inadequate depending on details (such as how wide the barrier is). Second, long journeys can be made much more plausible if they are explained as a series of smaller jumps rather than one great leap. And third, in the absence of evidence of such smaller jumps, it is very difficult to prove right or wrong someone who asserts that stepping stones existed in the past but have disappeared.*

Of course, the allegory of jumps across narrow ditches versus canyons can be applied to evolution. The word evolution *has been invoked to explain tiny changes in organisms as well as huge changes. These are often given separate names: Roughly speaking,* microevolution *describes changes that can be made in one or a few small jumps, whereas* macroevolution *describes changes that appear to require large jumps.*

The proposal by Darwin that even relatively tiny changes could occur in nature was a great conceptual advance; the observation of such changes was a hugely gratifying confirmation of his intuition. Darwin saw similar but not identical species of finches on the various Galapagos Islands and theorized that they descended from a common ancestor. Recently some scientists from Princeton actually observed that average beak size of finch populations changing over the course of a few years. Earlier it was shown that the number of dark- versus light-colored moths in a population changed as the environment went from sooty to clean. Similarly, birds introduced into North America by European settlers have diversified into several distinct groups. In recent decades it has been possible to gain evidence for microevolution on a molecular scale. For instance, viruses such as the one that causes AIDS mutate their coats in order to evade the human immune system. Disease-causing bacteria have made a comeback as strains evolved the ability to defence against antibiotics. Many other examples could be cited.

On a small scale, Darwin's theory has triumphed; it is now about as controversial as an athlete's assertion that he or she could jump over a four-foot ditch. But it is the level of macroevolution – of large jumps – that the theory evokes skepticism. Many people have followed Darwin in proposing that huge changes can be broken down into plausible, small steps over great periods of time. Persuasive evidence to support that position, however, has not been forthcoming. Nonetheless, like a neighbour's story about vanishing buttes, it has been difficult to evaluate whether the elusive and ill-defined small steps could exist… until now.

With the advent of modern biochemistry we are now able to look at the rock-bottom level of life. We can now make an informed evaluation of whether the putative small steps required to produce large evolutionary changes can never get small enough. You will see in this book [Darwin's Black Box] *that the canyons separating everyday life forms have their counterparts in the canyons that separate biological systems on a microscopic scale. Like a fractal pattern in mathematics, where a motif is repeated even as you look at smaller and smaller scales, unbridgeable chasms occur even at the tiniest level of life.*

Biochemistry has pushed Darwin's theory to the limit. It has done so by opening the ultimate black box, the cell, thereby making possible our understanding of how life works. It is the astonishing complexity of subcellular organic structures that has forced the question, How could all this have evolved?

Notebook Entry

In your Science Notebook prepare a sentence or two (or three) explaining what you understand of the concept of irreducible complex and Behe's views on intelligent design. Then, explain Behe's position to the concept of evolution in the era of modern biochemistry, using his analogy of the jumps in the canyon.

Once you have done this, consider how scientists communicate their ideas to their broader audience as well as to the scientific community that read their research and works, realising that a layperson's understanding and knowledge is vastly different to that of a professional. In many lessons we see the value of science communication and how effective communication can garner both support and respect for a concept of modern science. Being able to understand what is being shared, appreciating how it is relevant, and discerning where it fits within the broader scientific framework and conversation are all key elements within this process.

Students are likely to be aware of the controversy over Behe's work and contribution as, since its release in 1996, *Darwin's Black Box* has received considerable attention. In the tenth anniversary edition of *Darwin's Black Box* © 2006 Behe writes, "I had no idea of how very unsettling some people would find the concept of intelligent design". He also states that despite the opposition for the book, the science still stands and that much progress within modern science could be added to further support his view.