"To what extent have giant leaps in scientific progress been influenced by shifts within the scientists themselves?"

The path of scientific progress has never been a straightforward one. Darwin famously wrote "I think" above what would eventually become the hugely controversial theory of natural selection – but what he initially proposed was, in fact, far different to what is commonly regarded as common knowledge today. History has shown us, time and time again, that discovery will always be intrinsically tied to the personal lives and environment of the scientists themselves. Yet the correlation between scientific progress and shifts within the scientists remains unclear and seemingly impossible to quantify. One way in which this could be done, however, is through the assessment of the causes of giant leaps in science.

One of the most pivotal points in scientific history that resulted in a leap in our understanding of genetic development was the proposal of the theory of natural selection by Charles Darwin. Ironically enough, though his discovery is often used today as an attack on Christianity and its cosmological arguments, Darwin remained "quite orthodox" a Christian (self-described) until his early thirties. In fact, it was only through his growing doubt in the cohesiveness of the Church's scriptures that he began to study the theory of transmutation, specifically finding fault in the conflict between Paley's idea of a "delighted existence" in a "happy world", and the suffering that was prevalent in nature. This took an all too personal turn when tragedy struck in 1851: Darwin's own beloved daughter Annie died of illness. Such dreadful loss finally tipped Darwin over the edge. Finding it impossible to reconcile the idea of a loving creator with his own personal experience of tragedy, Darwin threw himself into his research on the transmutation theory.

It was not until many decades later that Darwin's toil was rewarded. Stopping only when his numerous ailments became too grave to bear, Darwin finally completed his magnum opus twenty years after its conception, emerging in 1859 as a book which was received with outrage and admiration alike. This was *The Origin of Species.* The crux of the controversy was that it suggested the individual species on Earth had not been created by God – rather, they had emerged over time due to natural processes, which Darwin termed "natural selection". In the deeply religious climes of Victorian Britain, Darwin's view was a decidedly unpopular one.

Despite this, his theory became widely accepted over time and was hugely significant. In contemporary times, the primary change he inspired was a shift from relying upon the Church to resolve questions and provide answers to instead science, as Darwin's theory of evolution implied that the message of the Bible, distilled down to its simplest – that man and all life on Earth had been created by God – was incorrect. This scientific coup was rendered all the more impressive given the theory of natural selection's initially divided response.

In modern times, Darwin's discovery gains even greater importance as the inspiration of many later scientists. Had he not proposed this theory, science as we know it today would look substantially different; Darwin accelerated the process of scientific advancement and hence allowed the field of genetics research to advance far quicker. For instance, successive scientists, like Ronald Fisher, were able to use Darwin as the groundwork for their research; without the theory of natural selection, Fisher would have been unable to develop his own contributions – most famously, Fisher's Principle – to the field of genetics, as this was inspired by the study of Darwin's theory in conjunction with

Mendelian ratios. Similarly, modern engineers utilise a form of natural selection during production, wherein several different models may be tested and then altered accordingly, as opposed to attempting to derive the best possible shape from first principles. Hence, not only limited to the contemporary field of biological sciences, the reach of Darwin's theory extends to the here and now – all of which would not have been possible so quickly if Darwin had not changed his faith.

Therefore Darwin can be cited as an example of how significant advancements in scientific discovery can be due to changes in scientists' themselves. Though Darwin began his career in the natural sciences as a devout follower of Christianity, his wavering faith is what led to the development of a theory that would serve as the foundations of the understanding of genetics and phylogeny today. Despite the risk, Darwin was determined to present his findings in the name of scientific advancement – this prioritisation of science over Christianity is the clearest indicator that a shift had occurred in the scientist, one which would, irreversibly, change the world.

In stark contrast to Darwin was Gregor Mendel, the famous "father of genetics", who is remembered today for his breeding experiments on pea plants. While both scientists contributed to the same field of inheritance – and indeed Mendel had even read Darwin's *Origin of Species*, translated into German (Galton, 2009) – the causes of their discoveries were precisely the opposite of each other. While Darwin's hinged upon his changing beliefs, Mendel's discovery of mathematical laws governing inherited features was only achieved through his determination and unwavering focus on his experiments. Mendel's dedication is often viewed today with some degree of incredulity and amazement: he spent over 7 years and planted nearly 30,000 pea plants in this endeavour. Mendel's unchanging mindset could be perhaps attributed to his monastic lifestyle and lack of outside responsibilities, as unlike Darwin, who juggled editorial work on top of his theory, Mendel was a monk and therefore was able to work unhindered and without external pressures.

Mendel's resilience and unwavering drive had a profound effect on the course of scientific history. Though his discovery was largely ignored until 30 years after his death, Mendel predicted that his "time will come" (Iltis, 1958). Sure enough, this proved to be true following his work's rediscovery by early geneticists in the early 20th century. Mendel served as the muse of many contemporaries like Thomas Hunt, who emulated Mendel's breeding experiments to study *Drosophila melanogaster* in hopes of learning the nature of the yet unknown 'units of inheritance' that Mendel had discovered. Incredibly, Morgan was able to identify sex-linked characters from the way that patterns of inherited eye colour differed from Mendelian ratios.

Consequently, Mendel's influence in today's times is seen in Morgan's discovery, the knowledge of which is used today to prevent genetic disorders like haemophilia from being passed on. This is often used in modern epigenetics, wherein genetic screening in vitro is used to reduce the likelihood of offspring being born with defects. Due to the prevalence of Mendelian phenotypes – approximately 8 million children are born worldwide with life threatening or disabling genetic conditions (Chong et al., 2015) – this is incredibly useful, as screening can be used to reduce the likelihood of a child being born with a genetic disorder, thereby preserving a high quality of life. One could very well argue that it was Mendel's consistent and unchanging approach that led to this discovery, as Morgan directly emulated his mathematical approach towards his breeding experiments, paving the way for modern medicine. But this runs counter to the trend shown with Darwin. So it is not possible to suggest that scientific progress is always due to scientists' developments; in Mendel's case, for instance, advancement occurred without a need for any change within the scientist.

In conclusion, the connection between changes in scientific advancement and the scientists themselves is a complex one – it would be an oversimplification to categorise the two as a simple cause-and-effect relationship. Rather, in the same way that an ouroboros devours its own tail, they feed off each other, as scientific discovery emerges after extensive research and experimentation. This can be evinced by Mendel's work. This discovery then results in scientists changing their beliefs and theories, consequently resulting in further advancements being made based on pre-existing information, like the alterations made to Darwin's theory. Thus, akin to the chicken or the egg causality dilemma, there is instead a cyclic relationship between them – the progression of scientific knowledge could not have been founded without research nor scientists' adaptability. Hence one could argue that giant leaps in progress have always been massively influenced by shifts within the scientists themselves – but *these shifts* had been originally caused, in turn, by new discoveries.