In the 150 years since Darwin wrote On the Origin of Species our knowledge of biology and genetics has increased enormously, leading to vast improvements in health and life expectancy. How might further understanding in these areas affect healthcare 150 years from now?

Undergraduate winning entry (Sean Brennan, Robinson College)

The biology of genetics has a great influence on healthcare: from knowing a patient's family history to the empirical analysis of genes in the living cells of that patient's body. It is often stated that "prevention is better than cure", and genetics leads science on its exploration of preventive medicine. Genetics has allowed us to identify potential problems – or predispositions – in patients only relatively recently, and to a limited extent; although we have managed to map the entire genome of a human, our actual understanding of genetic function lags far behind our knowledge of the pattern of genetic code. The boundaries of our current capabilities are gradually being pushed, expanding the potential for healthcare in years to come. Indeed, in 150 years time, the application of genetics to the practice of medicine will be drastically changed: for better, or for worse.

In many ways, the human race is less affected by Darwin's theory of evolution in modern times. The premise of this theory is that the environment will cause individuals with unfavourable traits to die and those with favourable traits to survive. It is therefore apparent that modern medicine works directly against the force of evolution, since it works to preserve the lives of those individuals with unfavourable traits. In any case we have the ability to easily manipulate our external environment, masking any unfavourable traits we may possess. The major influences in natural selection have shifted towards disease and how well people can defend themselves against pathogens. However, as it becomes less applicable to humans, this theory still helps us to understand the science behind genetics and biology.

It is difficult to predict how advancements in genetics would improve healthcare to patients in 150 years time. This is primarily because there can be no direct link between theoretical knowledge and the physical application of that knowledge. This is apparent today in the fact that several limitations to care are set by the resources available to doctors. Indeed, there are many conditions which are understood in great detail but cannot be treated due to the impracticability of treatment. An example that illustrates this idea is in cancerous tumours: we may know exactly where the tumour is and exactly what it entails, though we cannot practically remove every cancerous cell involved. The same may occur in genetics if we were to know where a mutation in the genetic code was, what gene was affected and what needed to be done to cure the problem – we could still not physically help. Hence, a deeper understanding of genetics would be useless without the techniques available for its application.

Every day, doctors are encountering patients whose symptoms they – and in fact, science – cannot explain. These vary greatly, from common annoyances like chronic back pain, to traumatic cases of Sudden Infant Death Syndrome. Although there seems to be no apparent reason for these occurrences, it is obvious that there must be some underlying physiological cause. In 150 years time, I would hope that problems such as these could be prevented (or at least understood) through advancements in genetics and the field of biomedicine.

Initially, further knowledge in these areas would be targeted at the prevention of disease. However, with time, the focus may begin to turn towards improvement of current health norms rather than the maintenance of these norms. In 150 years time, genetics may allow parents to ascertain the characteristics of an unborn child from very early in pregnancy, or even before fertilisation. Genetics may even allow these characteristics to be altered. This is of obvious advantage to the healthcare system as it allows potential problems to be addressed from the earliest possible stage of development. After all, it would be more effective to alter the genetic code of a zygote than attempt to alter the genetic code of

every stem cell in an adult human body. Of course, such capabilities would not come without an array of ethical issues. The main issue may be in drawing a line between a medical condition in an unborn child, and

genetic "disadvantage" in that child; should both of these be addressed by the healthcare system, and if so, can either be prioritised?

One area of the body which is particularly poorly understood is the brain. In 150 years time, understanding of the underlying biology of this organ may have increased tremendously. Analysis of the genetic code of an individual may give insight as to how their brain processes information. If specific genes involved in the formation of the brain and thought processes could be identified and manipulated, the healthcare system would potentially be able to treat mental illness as a more physical problem than a mental one. This is in great contrast to current treatment of mental conditions, where we tend to try and alter thought processes from the "outside-in", through counselling; this often proves to be a very slow and ineffective method. Essentially, doctors would be able to "re-wire" the brain to a more natural conformation, relieving any symptoms the patient may have. However, this potential would also raise many ethical issues. It may even be possible to operate on an individual's brain and alter their memories, their beliefs and many other aspects of their character. Although this sounds very much like science-fiction, I would suggest that it is not beyond the reach of medical advancement.

In 150 year's time, perhaps people will carry an identification card with their entire genetic code on it; taken from the moment they are born. A quick scan and the entire pool of that person's predispositions and previous family disease will pop up on a screen. This will make treatment a far more patient-specific and efficient process. Yet, with this blessing, many of the patient-doctor interactions will be lost, along with such questions as "Is there any family history of this?" and "Has this ever happened before?" Healthcare might become a very impersonal process, reducing the strong sense of trust most patients feel for their doctors, and the intimate concern most doctors have for their patients.

Perhaps in 150 years time, an increase in life expectancy will result in cancer being the single major cause of death – providing that a miracle cure has not already been found. Perhaps gerontologists will have discovered the mechanisms behind ageing and whether it is in fact an evolutionary advantage for organisms to age, or simply the culmination of damage to cells. It is possible that with such knowledge, the effects of ageing could be prevented, and an elixir of life found; a person born in 150 years time might live to be more than 200 years old! Some scientists even believe that such a person may have already been born. However, there will always come a time when such "progress" begins to compromise the system of healthcare. To whom would such an elixir be available? Perhaps there is a point at which genetic advancement will become detrimental to society and be forced to reach its limit.

150 years ago, On the Origin of Species was the first paper where the "why" in human biology was understood, rather than the simpler "how". Darwin gave a fundamental reason for why organisms take the form they do and why there seems to be such diversity on this Earth. In the 150 years since then, his theory has been used countless times to further our understanding of genetics and biology, as well as the anatomy of organisms. As discussed, advancements in genetics bring moral dilemmas which would need to be addressed. The human genetic code is an incredibly powerful piece of information which we have now acquired but cannot fully understand; as with a language, letters must be built into words and then sentences before we can read its message. Modern science is slowly achieving this and in time, our understanding of genetics will be greatly improved; this understanding has the potential to revolutionise current healthcare systems, and we should feel privileged to live in such an exciting time.