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HGSA DNA Day Essay Contest Winner
60 Years On: Still Coding for Cutting-Edge Science

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MESSAGE FROM THE EDUCATION COMMITTEE

In 2013, the Education Committee of the Human Genetics Society of Australasia (HGSA) established the DNA Day Essay Contest in Australia and New Zealand. The contest was first established by the American Society of Human Genetics in 2005 and the HGSA DNA Day Essay Contest is adapted from this contest via a collaborative partnership. The aim of the contest is to engage high school students with important concepts in genetics through literature research and reflection. As 2013 marks the 60th anniversary of the discovery of the double helix of DNA by James Watson and Francis Crick and the 10th anniversary of the first sequencing of the human genome, the essay topic was to choose either of these breakthroughs and explain its broader impact on biotechnology, human health and disease, or our understanding of basic genetics, such as genetic variation or gene expression. The contest attracted 87 entrants in 2013, with the winning essay authored by Patrick Yates, a Year 12 student from Melbourne High School. Further details about the contest including the names and schools of the other finalists can be found at http://www.hgsa-essay.net.au/. The Education Committee would like to thank all the 2013 applicants and encourage students to enter in 2014.

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The iconic DNA 'double helix' stands today as an enduring symbol of the scientific progress and advancement of the 20th century. Its discovery sparked a revolution in genetic engineering and precipitated the rise of modern biotechnology in ways its discoverers could never have anticipated. In an unobtrusive one-page article in *Nature*, Watson and Crick (1953) postulated that deoxyribose nucleic acid has two helical chains coiled around the same axis and that 'this structure has novel features which are of considerable biological interest' (p. 727). In perhaps the greatest understatement in biological history, the duo had built on decades of groundwork, the most notable of which was the contribution of English researcher Rosalind Franklin (Franklin & Gosling, 1953), who had come to a similar conclusion about the double-stranded nature of DNA before Watson and Crick through her work in X-ray diffraction. Franklin remains to this day unrecognized in the annals of mainstream history.

The landmark Watson and Crick (1953) article declared that DNA was composed of two outer sugar-phosphate strands with a nitrogenous base attached to each sugar and hydrogen bonds connecting the nitrogenous bases of the two strands to one another in such a way that adenine only bonds with thymine and guanine with cytosine. Thus, the pair created a model of DNA that is largely unchanged to this day, before astutely concluding that 'it has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for genetic material' (p. 737). By identifying the role DNA plays in the transfer of genetic material, the discovery of the double helix cleaved the study into the pre- and post-double helix eras and saw the birth of molecular biology.

The description of the double helix was the first important step in the development of techniques to cut, ligate, and amplify DNA, culminating in the creation of recombinant DNA (rDNA), or DNA created from multiple sources. Reece et al. (2011) outline the creation of rDNA by taking bacterial plasmids (small circular DNA molecules) and inserting the desired 'foreign' DNA by using specific

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restriction enzymes to create restriction fragments, which include the desired genes, followed by 'gluing' these fragments into the plasmid using DNA ligase. The new recombinant plasmid is then returned to a bacterial cell that will replicate to produce clones with the desired section of DNA to amplify the desired gene.

The development of recombinant DNA would not have been possible without the work of Watson and Crick in determining the structure of DNA and its function as the container for genetic materials. This coalesced with the idea that DNA regulates gene expression through protein synthesis to bring about the biological renaissance of biotechnology and genetic engineering.

Now that the advent of rDNA has been directly linked back to the discovery of the structure of DNA in 1953, it is directly responsible for the birth of biotechnology as a science, with all modern biotechnology based on DNA science. The notion of transplanting desired genes into a different organism using rDNA has come to be known as 'transgenics' and has had great impact on the utilization of genetic modification in agriculture; an example being the effect of gene construct pOnMTGH1, derived from sockeye salmon, on coho salmon as an up to 11-fold increase in weight and fish 37 times larger than those unmodified (Devlin et al., 1994). This advance in agricultural biotechnology has deep implications for future food security in a time of overfishing and exploitation of dwindling fish stocks.

A better-known example of modern biotechnology is the case of 'golden rice', developed to combat vitamin-A deficiency in regions of Asia, Africa, and Latin America that rely on carotenoid-free rice as their staple crop. Transgenics can be used to implant three new enzymes (phytoene desaturase, ζ-carotene desaturase, and lycopene β-cyclase) to enable the biosynthesis of provitamin-A (β-carotene) in the genetically engineered or 'golden' rice (Ye et al., 2000). This modification has the potential to prevent 1–2 million deaths a year linked to vitamin-A deficiency.

These remarkable advances in biotechnology, typified by transgenic fish and crops, would not have been possible if not for the techniques in genetic engineering made possible by decades of work culminating in Watson and Crick's article of 1953. So it is, 60 years on, that the cutting-edge research of today is based around that molecule of 'considerable biological interest': the DNA double helix that we all know and use.

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