



Writing Science-as-Fiction

to examine practice-led research in
creative writing as science communication

Sean Fitzgerald

ABSTRACT

This article seeks to outline how practice-led research provided the methodological focus for a recently completed doctoral study in creative writing as science communication. A selection of the findings is presented within this review document to offer a flavour of the processes involved and the approaches taken, delivered together with excerpts of creative practice, to illustrate how the critical element combines with the creative to produce a practice-led research outcome. The doctoral study examines how the representation of scientific knowledge can be critically explored through creative writing grounded in science and specifically, in this case, genetic science. The practice element is presented as a linked collection of genetic science-inspired speculative fiction in the form of two novelettes and one novella. These works present opportunities to explore scientific, ethical and moral issues within an area of contemporary-facing genetic science through fiction. As objects of creative production, these works offer the experience of engaging with science-related characters as they pursue their goals. This approach allows investigation through a range of methods to examine the creative process from a critical perspective using practice-as-research methodology. Through this exploration a critique is delivered on the influence of science in the design and writing of the collection.

Introduction

This research study examines how the representation of scientific knowledge can be explored through creative discourse, proposed through the writing of original fiction. In employing a practice-led approach, a collection of genetic science-inspired fiction has been written, in the form of two novelettes and a novella [1]. This practice is presented as a themed or linked collection of fiction stories: two novelettes (“The Commuter Lab” and “The Patient Experiment”), and one novella (*A Common Thread*). This thematic collection of content-linked stories is intended to present readers with a thought-provoking experience, whilst offering the opportunity to explore scientific, ethical and moral issues within the area of contemporary-facing genetic science. The writing offers a chance to examine up-close aspects of scientific and genetic laboratory practice, through original fiction. The activity of science (specifically genetics) and the generic processes associated with engaging in an empirical investigation, are explored as constituent elements of the individual stories. Through the writing of contemporary fiction, the narratives are presented as taking place in familiar, recognisable and relatable environments.

The initial focus of the research study has been to create science-inspired stories that deliver a selection of contemporary issues in genetic science. These works offer an insight into a range of the processes involved in genetic science, through a collection of engaging characters within accessible formats. This has enabled the interrogation of genetic science through a body of original creative practice, as wholly integrated, complete pieces of fiction. The motivation for this approach is two-fold: from a creative perspective, it is designed to bring an appreciation of the issues and processes of genetic science into works of general fiction, and from an academic perspective, it offers a selection of work to consider how to approach this delivery without resorting to either overt didacticism or over-simplification, and further offers the opportunity to interrogate pieces of science-as-fiction from inception to completion.

The central goal of this study is to investigate and question (through creative practice) whether (and how) the form of fiction can be employed to represent the empirical nature of science, scientists and the processes of undertaking science (including genetic science), through contemporary factual-based fictional characters and stories. As an integral part of this, the research further seeks to offer through applied practice an insight into potential

methods and approaches for using factual scientific material as the driver and content for creative practice.

Within the investigation, production of the fiction exists within a critical context of science in society and considers how contemporary writers utilise science—sometimes as a plot device, sometimes in the guise of a character, sometimes as a backdrop to the main story—in an effort to provide heightened dramatic tension that the inclusion of a science element can often bring to a story. This integration of recognisable science within fiction (whether contemporary or near-future speculation) can often bring with it both an appreciation but also a mistrust of science and technology. This duality can be illustrated through John Steinbeck’s biologist character “Doc” (based on Steinbeck’s friend and marine biologist, Ed Ricketts) in both the *Cannery Row* (1945) and *Sweet Thursday* (1954) novels, and Kazuo Ishiguro’s notion of human farms (illustrated through the experiences of the central characters of Kathy H., Ruth and Tommy) in *Never Let Me Go* (2005). For these examples the undertaking of science (and its consequences) has benefits and drawbacks, depending on who the character is. In an original story, “The Patient Experiment”, this duality is illustrated through Dr. Balfe’s actions. He feels mistrust towards the research facility where he is employed but realises that he is also in a unique position to bring compassion and comfort towards his patient, TP.

A critically-facing component of the study addresses issues such as the accuracy of an author’s approach to science (including associated technologies), the ways in which contemporary writers have used science in fictional narratives, and how the elements of science, technology and fiction can be viewed in the context of a late 20th century (and early 21st century) philosophical and socio-political perspective. The critical work also investigates whether concerns about the validity of both the scientific content and context are necessary, as the original stories and the science-as-fiction published works cited in this study, are ultimately works of fiction (albeit set in a recognisable and familiar landscape).

Approaching a mixed methodology

There are two major elements to this research study. Firstly, there is the creation and critique of a body of original creative writing in the form of three stories (two novelettes and one novella). Secondly, a critical element that includes an evaluation of practice-led

research as an analytical tool, developing a creative-critical approach to practice, and a consideration of that practice in a wider context of genre and non-genre writing.

As part of this critical element, an overview of a close-analytical study undertaken on Andrea Barrett's *Ship Fever* collection (1996) is presented. It is the work on this analysis that led directly to the development of the study's strategic creative-critical approach. The development of this was driven by necessity, as a suitable way of analysing science-as-fiction texts in an attempt to gain an insight into how they were written, constructed and whether there were any commonalities. A decision was taken to create a tailored approach, and so a set of criteria with which to examine various aspects of the writing, structure, character construction and the integration of the science involved, was devised. The resultant findings were introduced into the preparation work for the original creative practice, in order to instruct and inform its science content and storyline research, and the drafting, writing and editing of the pieces.

After completing some of the early stories in the collection—not all the fictions that were developed and written went on to be included in the final study—it was decided to evaluate this work critically using the tailored analytical approach with a view of applying a revised set of criteria to one of the collection, and one of Barrett's pieces. This became the basis for a comparative study between one original fiction (“The Patient Experiment”) and one from Barrett's collection (“Birds With No Feet”). The groundwork of this comparative study greatly influenced the shape and approach of the main research study. The comparative study itself is subject-specific and probably has a limited direct application outside of this approach. However, the reason for undertaking the comparison was to provide a measure in order to develop original practice along similar lines to achieve similar outcomes, and even though the practice collection is very different from Barrett's, they share common factors (as illustrated in the full results of the comparative analysis).

Cultivating a creative-critical approach across the research study has proved to be a very useful methodological addition. It has enabled an appreciation of how creative work can interact with a critical understanding to provide a wider scope for understanding how elements of the practice content affect aspects of the critical. An example of this would be how the depiction and exposition of

complex laboratory processes in “The Commuter Lab” may affect the reception of that information i.e. how the level of technical language could influence engagement with the story.

This leads into the main line of enquiry with this study: Through the production of creative practice-as-research, how do the stories in the collection explore implications and effects of genetic science in society, as they attempt to (re)present them as fictionalised but recognisable, contemporary and sometimes speculative scenarios? This approach allows the investigation of science through producing a body of original fiction utilising a range of methods including a creative-critical one. In addition, there is one further critical aspect that is addressed through the practice-led research, one that was touched on earlier with the question of “validity”: whether any of the contextual issues about how science is employed in narrative fiction are important or constructive considerations, as they are after all, works of fiction. It is argued that this *is* an important consideration and is something that can be examined in the light of real-world events. As a direct illustration, there is a fictional scenario in “The Commuter Lab” that speculates on the covert collection of personal information through a mobile (gaming) app in a relatively transparent but underhanded way. This directly reflects the recent Facebook and Cambridge Analytica debacle that unfolded during 2017 (a few years after “The Commuter Lab” was originally written)[2] and as such, it can be seen how fiction can be premonitory, as science (technology) and fiction travel down the same route, albeit on different tracks.

Writing science as creative practice

From the perspective of the original practice, genetic science has been primarily used as a “theme” rather than creating narrative fictions necessarily about science or scientists. The stories are generally character-centred, situated both in a recognisable (Western European) society and in recognisable scientific environments (i.e. either in a “laboratory”, “medical facility” or “field” setting). The core aim of this research is to investigate if and how fiction can be successfully employed to present the empirical nature of science, scientists and the processes of undertaking genetic science. A key methodology employed by this study is the development of practice-led research designed to deliver a collection of “speculative fiction” that brings together fictional scientific characters, their personal and scientific experiences, and a variety of accessible factually

based science and genetic science content. It is hoped with this collection of stories, the processes of science—specifically genetic science—will be delivered in a clear manner that will engage readers to follow both the narrative and the science with equal interest.

The collected practice is referred to as speculative fiction and, from the perspective of genre, is not regarded as (wholly) either science-fantasy or science fiction. The speculative element comes from how the ideas (theories) and technology are employed (through the characters). In speculative fiction the ideas (theories) and technology exist in the present. The original writing—in the collection—explores and exploits how, why and where these might be employed. Margaret Atwood (2005) suggests that science fiction and speculative fiction are two entirely different approaches to writing fiction: one is the future, of things which are imagined, and the latter is based on concrete ideas or technologies which are presently at hand (in a contemporary society). In considering the approach followed by the collection, this strongly aligns with Atwood's assertion that speculative fiction is a discrete approach, as it is based on elements that have their basis in fact, in the here and the now. However, it is inescapable that in reality, the collection will just as likely be categorised as science fiction, and for that reason, Adam Roberts' definition of the genre in his text, *Science Fiction*, is used as a fitting descriptor of the collected work, as that belonging to: "...a genre or division of literature [that] distinguishes its fictional worlds to one degree or another from the world in which we actually live: a fiction of the imagination rather than observed reality." (2000: 1).

In regard to the specific content focus of the research study, *New Scientist* writer Philip Cohen succinctly introduces the field of genetics as "...the study of how our physical and behavioural traits are inherited" (2006: 1). While this might seem like an over-simplification, the enormity of the field and the possibilities it offers—for fiction—are infinite. Although a selective field was chosen for the main research study rather than approach it from a generalised topic of "science", it is still representative of science and the processes of science. The decision to concentrate on genetic science was taken for two key reasons. Firstly, driven from a mix of personal interest and professional concern, the rapidly developing nature of genetic science means it is a fertile ground for contemporary characters, situations and storylines. Secondly, there is a high potential for producing research practice that has

direct contemporary relevance, as developmental genetic science and technology increasingly impacts on individual everyday lives.

The enterprise of genetic science, specifically those activities associated with areas of engineering, technology and human medical research, present many possibilities for creative story ideas. The subject-specific content offered by the science of genetics and genetic engineering inspired the practice collection, as the science proved consistently topical and very much an integral part of twenty-first century living. This combination provided an opportunity to produce a body of relevant and dynamic work written about, and aimed at, a contemporary society.

Practice-led research

From writing within a literature of ideas and possibilities, a "What if?" method allows the questioning of science and resulting technologies to act as a catalyst to prompt thought and debate. These "What if?" scenarios in the creative work are designed ultimately to be works of fiction that allow speculation about contemporary ideas in genetics. Lisa Tuttle in *Writing Fantasy and Science Fiction* considers this ability to ask the "What if?" question from within a "...literature of ideas, of wonder and speculation" (2005: 3) that is often prevalent in speculative fiction and science fiction stories (but not exclusively so). Tuttle's key observation on this "What if?" question underpins the developmental approach to the individual stories in the practice collection. The science behind the majority of the fictionalised scenarios is being applied authentically, so there is scope for the stories to act as a focus for the discussion of genetic science and allows a contemplation on how this may impact in the (very) near-future.

As an integral component of this practice-led research, the approach to writing fictional worlds (albeit ones based on various contemporary locations and recognisable backgrounds), has required accuracy, both in the development of storylines and in the ideas and progress of science issues contained within the stories. Without this attention to detail the fiction pieces would fall short of what was expected of them. In concentrating on whether the requirement for presenting an accurate scientific process is relevant or not, it does open up possibilities of how this issue could be useful in communicating features of science, as it provides an opportunity for dialogue. It allows for ideas about

new and proposed aspects of science to be aired and debated before the hard choices of reality have to be made.

Throughout this study, there has been a constant commitment to represent science and genetic science in a factual light, through a fictional lens. Part of this responsibility comes from recognising that the (mis) understanding of science can have repercussions. The media portrayal of science is often directly relevant to this situation, as its commentary carries meaning and weight in a population's perception of science and associated technologies[3]. With the stories it was held important that the relevance and validity of the science was able to be established through *how* the fictional portrayal measures up against the "hard"[4] science and genetic science breakthroughs, developments and applications in the everyday.

The ideas and stories in the practice collection are aimed at audiences who are receptive to creative possibilities, who will consider what they read and how these ideas may impact on themselves, in contemporary and near-future setting. The stories and story-worlds have purposefully been kept within the realms of current and recognisable environments, to assist in heightening their dramatic impact—and again, relevance—and to relate the body of work as pieces of contemporary fiction. Although at first look, elements of the stories in the collection could be regarded as science fiction or science-fantasy, the aim is not to categorise them in that way. As discussed earlier, the works are primarily speculative science-as-fiction, and to consider them otherwise could offset the full impact that this on-going practice approach has the potential to achieve.

Within the individual stories of the collection, "scientific enquiry" is both linked to the object[5] (specifically the "characters" of TP in "The Patient Experiment" and Judith in *A Common Thread*), and to the subject[6] of those individual fictions. The approach used in writing the fiction offers, as a feature of the storyline(s), the chance both to sample a taste of participating in a (fictitious) scientific enquiry, along with the experience of what it would be like to be at the centre of that enquiry too, through empathy with specific characters and their environments.

At the time of embarking on the practice-led study, a satisfactory outcome of the research practice would have been to produce a work of fiction that constructively engaged non-specialist readers with aspects of genetic science and general

scientific principles, processes and characters, in an entertaining and thought-provoking manner.

One of the main concerns in achieving the above outcome for the practice has been—and still is—to represent an empirical scientific process, that stands up to professional scrutiny, which offers a reader stories that are not didactic in nature but are informative and are able to be engaged with as contemporary fiction. To achieve anywhere near this goal has not been straightforward. The following quote from Michael Crichton appears at the start of *The Andromeda Strain*. It succinctly encapsulates the path that has attempted to be navigated:

This is a rather technical narrative, centring on complex issues of science. Wherever possible I have explained the scientific questions, problems and techniques. I have avoided the temptation to simplify both the issues and the answers, and if the reader must occasionally struggle through an arid passage of technical detail, I apologize.

(Crichton 1969: 12)

From a formal academic perspective, this practice-led approach has delivered a "non-standard" creative writing-as-research outcome (i.e. in comparison to a literary novel, a genre novel or a screenplay, etc.) and as such, the resultant output combines a mixture of genre and literary forms, in a collection comprising novelettes and a novella. The term "non-standard" is applied as the creative work bridges literary and genre fiction and could be considered as either a hybrid of the two standard approaches or occupying a space somewhere in-between.

Presenting the research practice

As the collection contained stories of mixed lengths, there was some thought given to re-formatting and "repackaging" the individual pieces as defined episodes or sequences, to present them collectively as a "story-book" or "novel-in-stories" (as was done so effectively with the UK publication of Jennifer Egan's *A Visit from the Goon Squad* (2011)). This did seem to be an attractive proposition to identify what the fiction collectively represented, as the stories were designed to be interconnected by the specific and non-specific technical processes of undertaking genetic science. However, it was decided not to overstretch that connectivity and so, the collection is presented as distinct pieces linked through elements of ideas, content and structure.

The stories stand as a collection of contemporary tales examining how the practice of empirical genetic science will have far-reaching implications in ways that can be both related to in present-day situations (and through real-life events) and imagined in the very near future. The collection encompasses a range of stories that begins with “The Commuter Lab” offering the basic tenets of undertaking genetic science and builds on this knowledge and understanding within each piece of the collection as it progresses. The final story, *A Common Thread*, is able to be freer of some of the mechanical detail of undertaking the processes of genetic science—precisely because of its interconnectivity—so is able to ask searching questions on the ethics and the morality concerning the present and very near future uses of the science, while treading lightly on the fringe of magical realism in the way that Atwood and Margaret Drabble manage so effectively.

Creative writing practice collection Development

During the initial stages of developing a suitable research methodology for the main study, a collection of science-inspired fiction outlines and ideas were identified, based on factual, contemporary science and scientists. These ideas were initially developed from a range of sources: scientists; academics; scientific peer-reviewed papers; science journal articles; newspaper articles; published fiction stories; conversations with those involved in mediating science and its communication; museum visits and exhibitions, and inspired from a creative but informed position with a concentration on the “representation” of science. One thing was apparent: the continued and increasing influence science (especially genetic science) has and will have, on modern society.

For each storyline chosen to be developed further as part of the practice-led research study, four distinct approaches were undertaken to help with establishing a methodological approach: a detailed focus on the representation of scientific and technological elements of the initial storyline; a critical consideration looking at the current reality and plausibility of the science and technology involved in the fictional constructs; the factual nature, or realism, of the science processes undertaken within the fictions, and finally, the factual nature (realism) of the final outcome of the science represented within the fictions. As these storylines were developed, there was a process of validating and re-validating the “hard” science involved, with

reference to scientific papers and research, and the introduction of new potential (speculative) ideas of genetic science and technology, to open up the storylines to what Markus Schmidt et al (2013) refers to as a “Sense of Possibilities”[7] (10), and Susan M. Gaines et al (2013) as “novels of ideas”[8] (7).

The creative writing collection of genetic science-inspired fiction consists of three extended or longer pieces of creative writing (two novelettes and one novella), that share the common general narrative theme of empirical science and more specifically, that of genetic science. In their collective form, the pieces total roughly the length of a small-sized fiction novel. Both the current (and continuing post-doc) practice-led research focusses (and will focus) on presenting pieces of science-as-fiction that highlight a range of potential effects and consequences for a society, as it starts to embark on human-based, empirical genetic and synthetic biological scientific research[9]. One aim of this creative practice is to help forefront and assist in bringing these scientific, ethical and moral perspectives, issues and discussions into a popular, public sphere for debate.

As a key element of the research methodology employed, it was planned that one of the initial pieces of genetic science-inspired fiction would serve as one half of a comparative creative-critical study[10]. The aim of this informative approach was to identify any distinguishing factors which were common, across two samples of science-inspired fiction. This technique was based on a detailed critical (and close) examination, that was carried out on Andrea Barrett’s (1996) *Ship Fever* collection of science-inspired fiction stories, during the early preparation stages for the research study. This critique was re-worked and condensed, to provide a framework where direct comparisons of key areas between science-inspired fictions of similar form, could be undertaken.

This initial framework design proved useful in identifying a representative sample of genetic science-inspired fiction, which in turn provided samples of both published and e-published works, as potential comparative texts to the proposed original, practice-led writing as research. Subsequently, findings from these comparisons were able to be fed back into the creative writing, to strengthen the study.

The sample of genetic-inspired fiction, ranged across novels and both longer and shorter stories, and included: *Generosity* by Richard Powers (2011),

Intuition by Allegra Goodman (2009), Bio Punk: Stories from the far side of research edited by Ra Page (Comma Press[11], 2012), and e-published works on Jennifer Rohn's webzine *Lablit.com*[12], including *An investigation into love by Babcock and Wainwright* by Pippa Goldschmidt (2015).

Creative writing as research

As an initial starting point, the examples of creative writing as research are about exploration of ideas inspired by genetic science, and the drama-based fiction which comes from that exploration, as an attempt, through the creative practice to explore the notion that there can be an equal appreciation and mistrust, in how credible scientific knowledge is understood.

Process, contexts and influences

This considers how a range of material from (principally) genetic science influenced and informed the research-led creative writing practice, from the initial sparks of ideas to developing characters, to creating realistic environments for the stories to unfold, and again, as part of the re-drafting process, all with an aim of producing credible, genetic science-inspired creative writing.

The following contains outlines of the three creative writing pieces (A-C) submitted as the principal focus of the practice-led writing as research study, along with samples of "hard" and "popular" science (genetic science) evidenced as indicators of this practice-led research approach. An excerpt from each story follows these outlines.

The main characters which feature in the practice-led pieces are not fictional scientists in the classic research mode as suggested by Rosslyn D. Haynes (2014) but instead are science professionals, medical specialists or similar "outsider" amateurs. This approach has purposely been chosen to try and address issues of exposition which can often be clumsily-handled in science-inspired fiction. The main characters in each of the three submitted fictions were chosen and positioned in such a way that part of their function was to learn about a particular aspect of genetic-inspired science, or its application as a genetic, bio-technology or bio-engineering problem.

The ideas, which were the initial inspirations for the three practice-led writing as research pieces submitted, are each based on factual elements, from

both the perspective of genetic science and also the cultural, story component. Starting from this narrative base, an aim has been to bring a certain realistic credibility to the practice-led writing as research.

Within the creative pieces, an effort was made to situate both the science of and processes of genetics, as plausible, within a contemporary setting. It is hoped that this has partly been achieved through using a factual basis for the initial story research highlighted above. To consolidate this notion of plausibility, each of the practice-led pieces have also had the benefit of revisions and additions, to enhance scientific credibility, as the fictions have developed and improved through re-visiting and re-working, where necessary, the "hard" science elements.

In terms of referring to these creative pieces as practice-led writing as research, there is confidence that the practice has informed how a factually-inspired genetic science-as-fiction is developed and written, with these findings then being fed back into the drafting process, to be re-written and developed, in both scientific and narrative terms.

The resulting aim with this approach to the creative and critically facing work is to consider the basis for exploring the development of fiction as practice-led research through the writing of genetic science-inspired speculative fiction.

The practice-led creative writing research outlined below, along with a specific example of each of their hard science and popular science/cultural inspirations, provides an initial insight into both the processes of undertaking genetic science as an empirical activity, and also helps to illustrate some of the ethical and moral consequences of exploiting and exploring this area of scientific endeavour, through fiction.

A. "The Commuter Lab": "An under-employed science graduate finds himself caught up in an illegal, real-world genetic experiment, trapped between a covert governmental organization and a fringe group of genome hackers."

"Hard": The initial idea for this story came from an article in the *New Scientist* entitled, "Rise of the garage genome hackers", (McKenna 2009), which looks into an "underworld" of amateur synthetic biologists and engineers, as they "tweak" microbial DNA, and specifically talks about "bio-weather" and

its role in “DNA-fingerprinting”. Further areas of “hard” science were added as the drafting process began, and the narrative required more scientific structure and components, for example, the whole real-world concept of a “Lab on a chip”, which controls small-scale DNA analysis of microfluidic samples, was identified from an online article by Dolomite Microfluids (2008) entitled “Microfluids to revolutionise DNA analysis.” This article provided part of the basis for the hackers to be able to analyse the stolen “bio-weather” sample.

“Popular”: Amongst the fads to emerge, in genetic science and engineering, is the sampling of genetic data known as bio-weather—unwittingly discarded skin cells, hair, mucus or other organic matter—referred to as “bio-trail” for the research story, and the microbes within this detritus. With respect to highlighting real-world techniques involved in the story, notably the replication of a DNA sample in order for it to be successfully analysed, Ben Goldacre in his attempt to deconstruct the “myth” of science with his book, *Bad Science* (2008), explains the use of the PCR[13] technique (the same techniques as used by the hackers in the story), to replicate a genetic sample as he investigates the controversy over the poor genetic science involved, in creating the media-fuelled, world-wide MMR scare in 2002 (304).

“The Commuter Lab” ©2018

(Fitzgerald 2018b. Section of story from pp.36-8.)

“Context description: Following an unexpected altercation, one of the two main characters, Peter, enlists the help of an amateur/outsider scientist (TT). Peter hopes his long-time friend can analyse the contents of the mysterious box he suspects contains evidence of an illegal covert science field-experiment.”

“Beep. Beep. Beep.” A soft alarm sounded in the Garage lab. Peter woke with a start. He slowly focused on TT who was bent over a laptop near the microarray unit.

“What’s going on?” Peter asked, barely awake.

“It’s okay mate you just nodded off for a few minutes. Not surprising really.”

“What’s that noise?” Peter sat up. He stretched his arms above his head and yawned. “Oh. I feel awful.” He looked at the clock. “It’s nearly midnight.”

“So it is. That’s just a notification alarm from the microarray. The analyses are complete. I’m browsing the results now. Interesting.” TT seemed distracted. “Come and

have a look.”

“No. Not that. The hissing noise? And what’s that smell?” Peter wrinkled his nose and coughed. “It’s like burnt pine needles?”

TT looked at his friend and then at the microarray. He sniffed the air. “Oh that. That’s just the waste processing gases being vented along with any unused test material from the analyser. All sterile by now of course thanks to a process called “extreme heat conditioning”. According to the manual anyway. I wouldn’t worry about it. Have a look at this.”

Peter gathered himself and joined TT who was clearly engrossed in the analytical results.

“What is it? Have you found something?”

“Loads of interesting stuff. Look.” TT moved away from the screen to let Peter have a clearer view. “On the left there you’ve got a standard analysis of a control sample from the City of London courtesy of QM. It shows what you would expect with fungi types such as *Trichoderma*, *Chaetomium*, *Nigrospora*, and bacteria groups such as *Streptococcus*, the *Bacillus* family, *Dermabacter* etc. Some are harmless but some of them can be deadly in the right strains, conditions and concentrations.”

“I do remember some of this stuff, you know,” Peter responded.

“Sorry.” TT smiled. “I was just trying to set the scene as it were. Okay?”

Peter nodded. He turned his attention back to the screen.

“The right-hand section should be listing the identified findings found *only* in the micro-vacuum sample after the control matches have been removed,” TT stated.

The area appeared blank. “If your databases are so comprehensive where are the matching results?”

TT didn’t offer any reply. He seemed to be deep in thought.

“That’s got to be pretty unusual. Wouldn’t you say?”

Again, nothing from his friend.

“According to that analysis, Randall or whoever it was didn’t collect anything out of the ordinary. So why all the fuss? Why the fracas with me? Why were the Met so keen to talk with both of us if all I snatched was a container full of traffic pollution? And you weren’t even there?” Peter let frustration and questions tumble out of him.

He rubbed his eyes just in case he had missed something. Nothing had changed. This made even less sense than before the tests. He

was intrigued by TT's continued silence. What can't I see, he wondered.

"So, what do *you* think is in it?" Peter asked. He knew from TT's reaction that there was more to this than a blank screen.

"The Network has access to very specialist biological and genetic databases. If we need to we can request help with an identification," TT said. He seemed to evade the direct questioning. "It's usually quite slow. However, I think we should use any possible sources of help we can get."

"What's this 'Network?' You've never mentioned them before?" Peter asked.

"You've never..." TT started.

"Needed to know before. Yes, I get it."

"Their official name is the Interactive Genetic Coding Database and Synthetic Biological Network, or IGCDSBN for short."

"I can see why it's referred to as the Network," Peter said. He moved back from the screen.

TT logged in to the IGCDSBN database. He opened an email and attached a data file containing the analytical results. TT sent this off anonymously to the Network's administrators.

"For now, that's all we can do in terms of possible identification. Let's see what the actual decoding can tell us." He minimised the Network window and opened up the test sample file.

Peter looked on and kept quiet. He knew how TT worked in the lab. It was best to observe and participate only when invited.

"Right. What have we got?" TT scanned the list of data for any clues. "So, what makes some of you so special that my own databases haven't been able to pick you out?" TT addressed the decoded micro-organisms.

"Here we are," TT said. "This profile is a bit more interesting. Survival across an extremely wide temperature range. Unusual for a fungus. Genome made up of eight chromosomes and over ten thousand genes. Fairly complex for such a small critter aren't you. Quite similar in make-up to an *Aspergillus*-type fungal spore. I wonder what your party trick is?" TT looked up. He turned to Peter. "Any ideas on this?"

Peter tried to focus his own thoughts. "Why would Randall be collecting this particular microbe? If he was willing to fight with a stranger to keep it, it must be worth something to him. Why is he trying to keep it under wraps?"

An email alert sounded. TT's focus was drawn to a multi-coloured flashing envelope icon at the bottom right of the screen.

"That's highly unusual. The Network has sent an immediate reply."

"That's good isn't it?"

"It's unnervingly quick. I've known it take weeks to get a reply from them before." TT sounded concerned.

"Open it and let's find out what we've got. If it's a new species we can name it. How about *Aspergillus Peterus*?"

"Somehow I don't think you'd want this type of fungal mould named after you. It could well turn out to be the cause of the next major bronchial epidemic."

"Oh," Peter replied. "Perhaps not, then."

TT hesitated just for a moment. He opened the email.

B. "The Patient Experiment": "A disillusioned junior doctor tries to escape an emotionally-driven episode which has blighted his fledgling career, as he seeks solace and purpose as a psychology researcher in a medical care centre, only to discover that perhaps some mistakes are destined to be repeated."

The initial idea for this creative practice came jointly from the work carried out at the University of Bath's Centre for Death and Society (University of Bath, 2005) and at the Centre for Death and Life Studies at Durham University (2008). Although both of these centres focus more on the humanities side, there are elements of empirical investigation used within the multi-discipline approach to their areas of study.

"Hard": "Experimental animal speaks" is quite an apt description for this story. Essentially, the "patient" can survive persistent clinical deaths. On closer investigation into whether the empirically based (medical and genetic) science aspects needed for this story to work were present, a whole range of material that could support a plausible story was uncovered. One of the main pieces came from an article by Benjamin F. Trump et al in, *Toxicologic Pathology*, (1997: 82-88) which provides evidence-based material on cell-death and injury, and how, given the right circumstances, it could be initially reversible.

"Popular": In the mainstream press and periodicals there has always been a fascination with near-death but occasionally articles do carry some elements of scientific weight and these were the ones that were followed for leads, ideas and further sources

of information. For this story, one such piece was a science-labelled 2010 article by Jonathan Leake, in *The Sunday Times*, “That’s not the afterlife – it’s a brainstorm”. This was particularly useful for the further development of “The Patient Experiment” as practice-led research, as it deals with oxygen-level driven electrical brain impulses at the point of near-death.

“The Patient Experiment” ©2018

(Fitzgerald 2018c. Section of story from pp.73-5.)
Context description: “One of the two main characters in the story, Jake, a medical researcher/doctor, contemplates his future in a new post. He suspects he may become embroiled in the unethical treatment of a long-term patient (known as TP). A friendly colleague, Jayne provides him with some much-needed background information.”

Jake sat in his office. It was three days since he had been in theatre. After a further restless night of dreams and waiting for a call in the early hours which never came, he felt exhausted. Slumped in the leather chair Jake mulled over TP’s more recent case history. He didn’t know what he was looking for. He was sure if there was anything incriminating or valuable it had been carefully removed.

He had returned to work the day after witnessing TP’s resuscitation process first-hand and checked with Jayne on his patient’s state of recovery. She assured him there was nothing to be unduly concerned about. This raised his suspicions and only made him more anxious.

A light tapping sounded on his door.

“Come in. It’s open.” Jake turned to face the doorway.

Jayne stepped into his office. “I hope I’m not disturbing you?”

“Hello, Jayne. No, you’re not disturbing anything.”

“You won’t uncover anything in those that they don’t want you to find,” Jayne pointed to the files in his lap.

“Thanks, Jayne. I’d already figured that one out after Sister let something slip in theatre”

“What did she say?”

“Something about TP suffering some short-term memory impairment”. For that I’d probably read minor brain injury or cell damage. I can’t find anything in TP’s medical notes to match it with.”

The young nurse’s face turned paler. She looked away.

“What is it? Here. Have my seat.” Jake

stood up and ushered Jayne into the chair. She sat down.

“It’s partly why I came to see you.”

“Why? What’s happened? Is it TP?” Jake felt his stomach drop.

“TP is out of the resuscitation chamber. He is in post-resus recovery but there were a few complications.”

“Such as?”

“He’s not made as full a recovery as was expected.”

“Is this to do with what O’Rourke let slip? The failure of the antioxidants to suppress the oxygen free radicals?”

Jayne looked at him blankly. “I’m sorry Jake, I don’t know anything about that. All I have been told is that TP sustained some cell damage within his brain cortex during the resuscitation process. I’m sorry. That’s all I know. I thought you’d like to know too.”

“What? When? Whilst I was there?” He asked in a flurry.

“Apparently the damage only came to light once the resus process had run its course. By then it was too late to try and reverse it,” she said. “I’m so sorry, Jake.”

“Can I see him?”

“He’s in the Isolation unit. Sister’s only allowing post-resus medical personnel in for the time being.”

“Oh.”

“And in case you’re thinking of visiting on the quiet there are two rather large orderlies guarding his door. It wouldn’t be wise without Sister’s permission,” Jayne advised.

An awkward silence settled over the office. Jake moved to the corner. The realisation of TP’s condition started to sink in.

Jayne shuffled in her seat. She looked as though she was deciding whether to add something further. “There was another not wholly unconnected reason for coming to see you.” Jake looked over at her. “There’s more?”

Jayne sat forward. “Has anyone mentioned the name of another clinic to you? The Harvey Clinic? It’s the Centre’s partner establishment in Chelsea. Just off the Kings’ Road?”

“Can’t say they have. What’s it got to do with TP’s situation?”

“Directly, nothing. Indirectly, everything. It’s connected to what happened to TP in resus.”

“I’m not in the mood for cryptic clues Jayne. In plain English please. What are you trying to tell me?”

“Okay. This is just for TP because I like the old guy.” She composed herself. “The Harvey Clinic treats the well-heeled for depression, drug abuse, psychological problems, materialistic addiction. You know the sort of thing?”

Jake nodded.

C. *A Common Thread*: “A seasoned anthropological researcher is seconded to a micro-biological project in unusual circumstances, where she finds that her analytical skills are not the only thing the experimental project requires of her.”

The initial idea for this story came from an editorial news article in the Science and Society section of the *New Scientist* entitled “Discovering the tomb of Jesus, wife and son” (2007: 7). The article speculates that any possible descendants from Jesus Christ and Mary Magdalene could be traced through Magdalene’s mitochondrial DNA. This started a thought process along the lines of an amateur scientist/bio-hacker who plunders grave sites of famous and key-historical figures in order to steal genetic material, in an attempt to sequence it and catalogue the genome.

“Hard”: With this piece of creative writing, there are elements of “hard” science prevalent in *A Common Thread*, most notable in the extraction of DNA and the processes involved. In addition, there are more specific areas, including the work currently being undertaken at the Virtual Physiological Human Institute for Integrative Biomedical Research (VPHI 2011) which is an EU-sponsored research institute whose main aim is to construct real-time medically-accurate, software simulated, virtual human models.

“Popular”: As well as commenting and speculating (from a “popular” science perspective) on the many uses for genetic science, with an increasing focus on synthetic biology, journals such as the *New Scientist* offer useful and informed introductions to a whole range of scientific subjects. Two example articles which have been consulted during the on-going development of this practice-led research are: Philip Cohen’s (2006) “Introduction: Genetics” and Michael La Page’s (2011) “Read me a genome”. A further example of utilising popular genetic science to inform practice-led writing as research comes from an article by Tim Rayment in *The Sunday Times*, “Do keep up, doctor, this is changing medicine for ever” (2011). This article considers how much more of medicine will be genetics-based, and increasingly will be part of a synthetic biological revolution.

***A Common Thread* ©2018**

(Fitzgerald 2018d. Section of story from pp.101-7.)
Context description: An anthropology researcher (Judith) has been seconded without much choice into a molecular genetics professor’s current research project. Judith is a bit bemused by the whole idea but needs the work, whilst her own supervisor is on extended leave. Information is slowly revealed to her about the project, aspects of which she finds worrying. In this part of the story, the Professor (Charles) discusses some of the background to the project.

I parked my bike outside the entrance to Psych-Anth. A couple of minutes to spare, that’s good. No competition for the undercover areas today. The campus was near empty save for a few maintenance vans. Even so I made sure my bike was locked. A habit borne out of experience. I walked around the perimeter of the low-rise Science Faculty building. All the connecting passageways and corridors had been closed up for the break.

Just on ten o’clock I came up to the entrance of Molecular Biology as instructed. The Pilgrim Bell sounded far off in the distance of the city. As the last chime struck one of two side doors marked Emergency Exit opened. The professor beckoned me in. Yesterday’s feeling of unease returned briefly.

I entered into the bottom floor of a stairwell. Once inside the professor closed the door firmly behind me. It was a fairly gloomy space. Unpainted concrete walls and emergency lighting. Classy.

“Glad you could make it. Thank you for being on time Ms Catchpole. Can I call you Judith?”

“Judith is fine, prof.” Familiarity cuts both ways professor, testing him.

“Me prof, you Judith.”

I smiled at his riposte. “Looks like we’ve both discovered a sense of humour.”

He returned my smile.

“Where are we working then?” I asked. “Have you got any fresh milk?”

“First floor, second door on the left. Fresh milk and coffee, or tea if you prefer.” He pointed up the stairs. “You lead the way. I just have to finish securing the door.”

As I climbed the stairs I glanced back. The professor seemed to be reconnecting security wires to the pressure pads at the top and either side of the double doors. My disquiet lingered. I moved on as directed with the professor now

close behind.

We entered a large laboratory teaching space. On one side the wall was mostly plate glass. The opposite was magnolia fibreboard. This had been papered with undergrad instructional posters. These mostly showed graphics of cells containing unravelling strands of double helices complete with sections magnified to reveal the complexities of genetic information. Apart from the odd tray of lab dishes and various *Pyrex* glassware, the over-riding theme of this teaching lab was probably the one thing most in common with all the other labs in the Science Faculty. The dominance of desktops, flat-screens and the occasional printer.

“Go on through to the back. There’s a separate office area.”

I hadn’t picked out the office at the rear of the lab. The unfurled blinds were beige and mixed in so well with the lab’s walls. I opened the door to the office and was immediately greeted by the set-up from Christmas Eve. This time in a slightly larger space. The professor squeezed around me as I stood in the doorway.

“Like a home from home,” he stated.

“For you, maybe.”

“We’ll see ...”

After a brief silence the professor swept his hand before him. “Come in. Make yourself ... at home.”

“Thanks.” I was glad to be able to take off an outer fleece layer. The bike ride wasn’t that bad from home to the Uni now the cycle routes had been completed. But you always felt so much hotter than it actually was.

“Good. Take a seat,” the professor pointed to a small settee in the corner of the room.

There was a square table and a chair there too. A laptop, the professor’s I presumed sat half-open on the table. I guessed this was a break area for him.

“Coffee? Tea?”

“Tea would be great. Dash of milk. No sugar. Thanks.”

“Right. I’ll be back in a minute. Have a look around if you like?” He disappeared out of the lab.

I didn’t take up the offer. I stayed put as it was warm and fairly comfortable. And I was still yet to fully disentangle myself from the army surplus shoulder bag which seemed to contain my life these days. True to his word the professor returned with a couple of mugs and a packet of Garibaldis. He placed these down in

front of me.

“Thanks,” I offered. “Garibaldis...haven’t seen those in years.” I opened the packet and snapped one off. There was no standing on ceremony when biscuits were involved.

The professor smiled and took one himself. He sat down in the chair opposite and took a sip of his acrid-smelling coffee. He leaned forward. “I suspect you are wondering why I requested you in today. On a bank holiday.”

“Just a bit,” I replied. “To be honest I’m only here out of curiosity.”

“That’s okay...” the professor hesitated but didn’t add anything further.

“I figured on the way over here, that it was unlikely that the FSS would let you remove equipment containing classified and personal information from a secure government building.” There was no noticeable reaction from the professor. I let this settle for a few seconds. “So. One of two things has happened. Either we have just committed a grand theft of government intellectual and physical property. Or the research project you outlined on Christmas Eve has stayed exactly where it was and what you’re working on is something related but different” I felt pleased with myself and took a long drink.

The professor stared at me for a short while. “Not bad. Eustace was right to recommend you. There is some truth in both your accounts.”

“There is?” I felt sick. What have I become mixed up in?

“Don’t worry. The first one not so much. The Home Office won’t be trying to track you down. The second one though is fairly spot on.”

“Explain please” I managed.

“With the FSS official project. The one I told you about,” he said. “All the data I had been working with was put into secure storage as soon as the preliminary and restricted notice of closure came through. That was two weeks before the Christmas break. What we ‘borrowed’ the other day was the bare bones software and hardware. Understandably this is quite a sensitive area for the Home Office. They kept a very close eye on me with regards to their data.” The professor’s voice had a deliberate and measured tone about it.

It sounded like he had rehearsed this short talk more than once. “Perhaps they had good reason,” I retorted. I hoped there was a look of displeasure on my face.

The professor seemed unfazed. “With no official data to work with for the last couple of weeks, I decided to introduce some of the material I had been collecting for just such an eventuality. I didn’t think it would present itself so soon.”

“What sort of ‘material’?”

The professor looked at me plainly. “DNA of course. What else would I be collecting?”

Silly me. “Specifically, whose genetic material have you been collecting?”

“We’ll get on to that presently. If you bear with me I can show you.”

If this was meant to placate me it had the opposite effect. Calm down Judy. Calm down. Let the man speak. A few seconds ticked by and my blood pressure dropped. “Sorry, Professor. Carry on.”

“Thank you,” he said. “The unexpected closure was a shame as I was starting to get some interesting results with the FSS project. However, for my personal research it presented a real opportunity. With the DNA material the Home Office supplied, I was able to refine a couple of the analytical techniques to a point where I started to generate measurable data. As a result, my own work starts from a much higher place on the development curve.”

“Going back to my earlier point. Do you, or *we* I suppose now have official permission to use this equipment?” I gestured at the array of quietly humming boxes sitting on the lab bench.

“Yes. Although...”

“A straight answer would be appreciated.”

The professor looked at me. He appeared to hesitate. “Yes. We do.”

I let out a sigh of relief.

“But maybe not exactly from the right people,” he added.

“What does that mean?” I could feel my frustration boiling up again.

“The person in charge of research at the Southwark HQ sanctioned the equipment’s use for my personal research, after the workload for the FSS had been completed. He agreed that it could be used off-site for a specified time as long as all the government data remained securely with them.”

“That all seems reasonable. So why all the apparent cloak and dagger stuff?”

“Two days later that same head of research was dismissed and paid off. Left the building that day. Escorted out apparently. I wasn’t even there to pass on my best wishes. There’s to be

no replacement. Effectively all the research programmes have been kicked into some very long grass.”

“That government-sponsored lawn must be more like a savannah these days,” I said.

The prof nodded.

“So, where does that leave the issue of the equipment? Which you now conveniently have off-site?”

“As far as I’m concerned I have an authorised and signed order. This entitles me to pick up the equipment for use in my research.”

“For how long?”

“I’d like to think indefinitely. However, I suppose we’ll have to work on the premise that come the fourth of January they may expect it back. With all their research programmes cancelled including my own, there will be no more work on the project in Southwark. So technically we’ve got it at least until they ask for it back,” the professor replied. “Being realistic we should work on the fourth as being our last certain day of research,” he added.

“Why then?”

“That’s when they are all due to return from their Christmas break, if anyone is left after the cuts.”

“Okay.” I weighed up the professor’s comments. “So, who knows that you have it?”

“The *ex*-head of research and the security guard. I suppose it will be documented on a slip of paper somewhere.”

I felt relieved that we hadn’t technically stolen anything. “Not as straightforward as I would have liked but I can live with it.”

What I didn’t impart to the professor was a two-year probation order in my distant past. I could do without any trouble re-visiting me from a desperate and violent time I’d rather forget. The prof didn’t need to know any details as long as he was being straight with me. I suppose I didn’t have much choice now. I just had to take his word and place my trust in him.

Concluding remarks

An ambition of this research study is that through following a “practice of writing” methodological approach, the outcomes offer a contribution to knowledge and understanding in the growing areas of Practice-as-Research and Practice-Led Research within creative arts that also transects science communication and the medical humanities. The scope of the project in the area of science

communication contributes to a general knowledge of scientific process and the undertaking of science and genetic science, examined through creating contemporary fiction. The purpose of highlighting some of the involved practices of genetic science to audiences who may or may not be familiar with broad concepts and consequences, is an attempt to engage individuals with glimpses of detail to help prompt further involvement with the processes of scientific investigation.

This scholarship offers at its core one method of engaging audiences—readership—with a content and a style that is designed to be different from what they might normally experience. To accommodate this, efforts have been made to keep the substance of science and genetic science within recognisable boundaries, in line with those of a detailed news report or popular magazine article. When attempts are made to engage readers with ideas and concepts they may find unfamiliar, these elements are incorporated within a general knowledge of genetics and science. This practice-led approach requires readers to be comfortable with both the story content and style, as everyday pieces of fiction writing. It is hoped these collected stories will be enjoyed without (some of) the pre-conceptions of how the workings and processes of science are often presented within popular media.

In the practice-led study, science-inspired writing explores and situates the processes of science and genetic science through contemporary fiction, in an informed mix of the possible and the probable. It is through this dual-approach (as evidenced in the resulting critical contextual study) that the strength of the ideas, subject-research and applied practice all combine to produce a collection of work that offers a distinctive methodology in the use of science-based characters and scientific material, in creating a selection of contemporary speculative fiction.

With this study, the research investigation has been centred on the extent to which it is possible to create a genetic science-inspired contemporary fiction that delivers the science, the processes of science and a glimpse of the scientific environment within the story, in an accessible and engaging method. This interrogation of science and genetic science within creative (writing) practice proposes a “What if?” question that enquires along the lines of, “What would happen if this piece of research was introduced into clinical medicine?” or “What

if the resulting treatment derived from that genetic breakthrough was introduced into a section of the population?” The initial proposition afforded by using a speculative approach was intended to create resultant fictional stories that operate within a factually based frame. This has enabled the presentation of the scientific elements and processes of the stories—as well as their nature—to be designed with the emphasis placed on authenticity and speculation, rather than fantasy. The practice collection and the critical context rationale together help determine the success in using the ethos of a scientific endeavour as the basis to inspire a plausible and authentic fiction.

Through employing a practice-led approach, relevant issues of form and genre in creative practice have been addressed. There was always a balance to be reached between what to say *with* the fiction (critical reception) and what to say *in* the fiction (creative reception). The choices made both in the communication of scientific material and the design of the characters and their stories, enabled the creation of a critically facing collection of science-as-fiction set in contemporary society within a speculative framework, all bound together by genetic science. The practice collection sits solidly in a speculative fiction category that occupies a middle ground between the broad groupings of literary and genre fiction and slips, on occasion, into social science fiction.

Practice-based research is often a keen topic of educational debate. At the beginning of the research study process, there were tentative concerns at the prospect of creative (writing) practice-led scholarship being considered as the type of research that would generate new knowledge. From the perspective of having now completed that practice—alongside the associated contextual work—it is appreciated that research is rooted as much in the process as on the focused outcome. In terms of referring to practice-based writing as “knowledge” and “research”, there is a confidence that the practice—and contextual—work critically informs how a factually inspired genetic science-as-fiction is developed, designed and written.

Notes

1. Tuttle in *Writing Fantasy and Science Fiction* (2005) offers a useful quantitative guide for a range of fiction forms. These have been used as a benchmark for the purposes of this study. Tuttle offers a quantitative definition of "...the novelette [as] from 7,500 to 17,500 words; and the novella from 17,500 to 40,000 words" (115).
2. For a detailed consideration of this news story and its chronology see *The Guardian* article, "Revealed: 50 million Facebook profiles harvested for Cambridge Analytica in major data breach" by Cadwalladr and Graham-Harrison (2018). In collaboration with *The Observer* and *Channel 4*, this piece broke the story on the deceitful collection and abuse of privileged profile data by Facebook and Cambridge Analytica primarily during the 2017 US Presidential election. Available at: https://www.theguardian.com/news/2018/mar/17/cambridge-analytica-facebook-influence-us-election?CMP=share_btn_link [24 March 2018].
3. Discussion of how both the "sociology of science" and the "philosophy of science" influence a communication approach in the creative writing of science, is discussed at length in the body of the research study.
4. For the purposes of this study, "hard" science is regarded as scientific study based either on solid scientific theory or empirical evidence.
5. "Object" taken as one of the main characters, to whom the science/genetic engineering is (physically) happening to.
6. "Subject" taken as what is being sought in respect to the story's scientific/genetic aspects and/or the storyline itself.
7. In this paper, Schmidt et al. use the term "sense of possibilities" to describe both narrative fictions about "real" or realistic science, as well as fictional science elements, within wider narrative fiction.
8. Gaines et al., describe these as works which contain scientific elements along with other aspects from a wide range of styles and genres including romances, mysteries, philosophical or thrillers, and crucially, with authors familiar with and/or educated in the humanities/arts and sciences.
9. A recent paper in the *Public Understanding of Science* journal on this debate (Schmidt et al., 2013), refers to a similar approach to contemporary creative work, as "Diegetic Prototyping" (1), which uses technologies and science currently on the "drawing board", as potential avenues of inspiration for creative fiction pieces.
10. Boulter (2007: 2), suggests that a creative writer's work benefits from that writer being able to critically appraise their own work and feed this back into their creative process.
11. Comma Press have published three collections of short stories: *When It Changed* (2009), *Litmus* (2011) and *Bio Punk* (2012), which tackle the main subjects of: science into fiction, modern science and the far side of genetics/genetic science research, respectively. The approach of the editors (Geoff Ryman and Ra Page) is a unique one, as each fiction author is paired with a scientist, who provides a short "Afterword" commentary on the context of the science issues raised in the short fiction pieces. The approach employed in the collected practice-led writing as research, is to try to combine both elements, so the fiction contains scientific "explanations" without any overt didacticism.
12. Rohn's webzine, *Lablit.com: the culture of science in fiction and fact*, is an invaluable resource, which brings together the worlds of "Hard Science", "Popular Science" and "Science as Fiction" and offers a platform for aspiring writers of "science as fiction" to be e-published.
13. PCR: Polymerase chain reaction, which is carried out by a PCR Machine or Thermocycler.

References

- Atwood, M. (2005) "Aliens have taken the place of angels: Margaret Atwood on why we need science fiction". *The Guardian: Film* [online]. 17 June. Available from: <https://www.theguardian.com/film/2005/jun/17/sciencefictionfantasyandhorror.margaretatwood> [20 June 2017].
- Barrett, A. (1996) *Ship Fever: Short Stories Collection*. New York: W.W. Norton & Company.
- Boulter, A. (2007) *Writing Fiction: Creative and Critical Approaches*. Basingstoke: Palgrave Macmillan.
- Cadwalladr, C. and Graham-Harrison, E. (2018) "Revealed: 50 million Facebook profiles harvested for Cambridge Analytica in major data breach" *The Guardian* [online]. 17 March. Available from: https://www.theguardian.com/news/2018/mar/17/cambridge-analytica-facebook-influence-us-election?CMP=share_btn_link [24 March 2018].
- Cohen, P. (2006) "Introduction: *Genetics*" *New Scientist: Life*. 4th September, Reed Business Information. Available from: <http://www.newscientist.com/article/dn9964-introduction-genetics.html#.VRR-A-Y7-XhI> [23 March 2011].
- richton, M. (1969) *The Andromeda Strain*. London: Jonathan Cape.
- Dolomite Microfluids (2008) "Microfluids to revolutionise DNA analysis" 7th March. Available from: <http://www.laboratorytalk.com/news/dol/dol110./html> [7 July 2009].
- Durham University (2008) *Centre for Death and Life Studies* [online]. Durham University. Available from: <https://www.dur.ac.uk/cdals/> [6 April 2010].
- Egan, J. (2011) *A Visit from the Goon Squad*. London: Corsair.

- Fitzgerald, S. A. (2018a) *Writing genetic science-inspired fiction in contemporary society*. PhD Thesis, University of Winchester, unpublished.
- , -. (2018b) "The Commuter Lab". Novelette, PhD Thesis, University of Winchester, unpublished.
- , -. (2018c) "The Patient Experiment". Novelette, PhD Thesis, University of Winchester, unpublished.
- , -. (2018d) *A Common Thread*. Novella, PhD Thesis, University of Winchester, unpublished.
- Gaines, S. M., Kirchhofer, A., Schaffeld, N., Schimank, U. and Weingart, P. (2013) "Fiction Meets Science: Background and Concept" *Fiction Meets Science Concept Paper 1*. Bremen: University of Bremen. Available from: http://www.fictionmeetsscience.org/ccm/cms-service/stream/asset/?asset_id=1133006 [30 October 2013].
- Goldacre, B. (2008) *Bad Science*. London: Fourth Estate.
- Goldschmidt, P. (2015) *An investigation into love by Babcock and Wainwright* [online]. Available from: <http://www.lablit.com/article/856> [6 May 2015].
- Goodman, A. (2009) *Intuition*. London: Atlantic Books.
- Haynes, R. D. (2014) "Whatever happened to the 'mad, bad' scientist? Overturning the stereotype" *Public Understanding of Science*. Published online 10 June, pp.1-14. Available from: <http://pus.sagepub.com/content/early/2014/05/30/0963662514535689> [11 June 2014].
- Ishiguro, K. (2005) *Never Let Me Go*. London: Faber and Faber.
- La Page, M. (2011) "Read me a genome". *New Scientist: News*. 16th February, Reed Business Information. Available from: <http://www.newscientist.com/article/dn20137-read-me-a-genome.html#.VRRBS47-XhI> [23 March 2011].
- Leake, J., (2010) "That's not the afterlife – it's a brainstorm". *The Sunday Times*. 30th May, p.7, Times Newspapers Ltd.
- McKenna, P. (2009) "Rise of the garage genome hackers". *New Scientist*. Issue 2689, 3rd January, pp.20-21, Reed Business Information Ltd.
- New Scientist* Editorial, (2007) "Discovering the tomb of Jesus, wife and son". *New Scientist: Science in Society*. Issue 2593, 3rd March, p.7, Reed Business Information Ltd.
- Available from: <http://www.newscientist.com/article/mg19325934.200-discovering-the-tomb-of-jesus-wife-and-son.html> [19 January 2009].
- Page, R. (Ed.) (2012) *Bio-Punk: Stories from the far side of research*. Manchester: Comma Press.
- Powers, R. (2011) *Generosity*. London: Atlantic Books.
- Rayment, T. (2011) "Do keep up, doctor, this is changing medicine for ever". *The Sunday Times*. 7th August, News Review, Times Newspapers Ltd. Available from: <http://www.thesundaytimes.co.uk/sto/newsreview/features/article695135.ece> [14 August 2011].
- Ryman, G. (Ed.) (2009) *When it changed: Science into Fiction: An Anthology*. Manchester: Comma Press.
- Rohn, J. (2005) *Welcome to LabLit.com: The culture of science in fiction and fact* [online]. Available from: <http://www.lablit.com/article/1> [5 April 2010].
- Schmidt, M., Meyer, A. and Cserer, A. (2013) "The Bio:Fiction film festival: Sensing how a debate about synthetic biology might evolve". *Public Understanding of Science*, published online 28 October, pp.1-17. Available from: <http://pus.sagepub.com/content/early/2013/10/24/0963662513503772> [30 October 2013].
- Steinbeck, J. (2000) [1945] *Cannery Row*. London: Penguin Modern Classics.
- Steinbeck, J. (2000) [1954] *Sweet Thursday*. London: Penguin Modern Classics.
- Trump, B. F. et al, (1997) "The Pathways of Cell Death: Oncosis, Apoptosis, and Necrosis" *Toxicologic Pathology*, vol. 25, pp.82-88, Sage.
- Tuttle, L. (2005) *Writing Fantasy and Science Fiction*. 2nd ed. London: A & C Black.
- University of Bath (2005) *Centre for Death and Society* [online]. University of Bath. Available from: <http://www.bath.ac.uk/cdas/> [6 April 2010].
- VPHI (2011) *Building the Virtual Physiological Human* [online]. Virtual Physiological Human Institute for Integrative Biomedical Research. Available from: <http://www.vph-institute.org/> [7 May 2012].

Bibliography

- Ashbrook, T. (2017) "A Gene Editing Breakthrough" *Center for Genetics and Society* [online]. 8 August. Available from: <https://www.geneticsandsociety.org/article/gene-editing-breakthrough> [11 August 2017].
- Atwood, M. (1996) [1985] *The Handmaid's Tale*. London: Vintage.
- Beer, G. (1983) *Darwin's Plots: Evolutionary Narrative in Darwin, George Eliot and Nineteenth-Century Fiction*. London: ARK Paperbacks.
- Brewer, P. R. and Ley, B. L. (2010) "Media Use and Public Perceptions of DNA Evidence". *Science Communication*. 32 (1), pp.93-117.
- Brier, S. (2006) "Ficta: Remixing generalized symbolic media in the new scientific novel". *Public Understanding of Science*. 15 (2), pp.153-174.
- Chevalier, T. (2009) *Remarkable Creatures*. London: HarperCollins.
- Collins, H. and Pinch, T. (1998) *The Golem: What You Should Know about Science*. 2nd ed. Cambridge: Cambridge University Press.
- Crichton, M. (1991) *Jurassic Park*. London: Arrow Books.
- Dick, P. K. (1999) [1968] *Do Androids Dream of Electric Sheep?* London: Millennium.
- Docx, E. (2011) *The Devil's Garden*. London: Picador.
- Doyen, E. (2012) *Novel Writing: Imagination on the Page*. London: Creative Commons.
- Gaines, S. (2001) "Sex, love and science". *Nature*. 413 (6853), p.255.
- Gordon, R. (2009) "Learning from fiction: applications in emerging technologies". *Bulletin of Science, Technology & Society*. 29 (6), pp.470-5.
- Haynes, R. D. (2003) "From Alchemy to artificial Intelligence: stereotypes of the scientist in western literature". *Public Understanding of Science*. 12 (3), pp.243-253.
- Kelty, C. M. (2010) "Outlaw, hackers, Victorian amateurs: diagnosing public participation in the life sciences today". *Journal of Science Communication* [online]. 09 (1), pp.1-8. Available from: [http://jcom.sissa.it/archive/09/01/Jcom0901\(2010\)C01/Jcom0901\(2010\)C03](http://jcom.sissa.it/archive/09/01/Jcom0901(2010)C01/Jcom0901(2010)C03) [14 April 2010].
- Kirby, D. A. (2003) "Scientists on the set: science consultants and the communication of science in visual fiction". *Public Understanding of Science*. 12 (3), pp.261-278.
- Kuhn, T. (1962) *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.
- Lambourne, R. (1999) Science fiction and the communication of science. In: Scanlon, E., Whitelegg, E. and Yates, S. (Eds) *Communicating science: contexts and channels*. London: Routledge.
- Ledford, H. (2016) "CRISPR: gene editing is just the beginning". *Nature* [online]. 531 (7593), pp.156-9. Available from: <http://www.nature.com/news/crispr-gene-editing-is-just-the-beginning-1.19510> [22 July 2016].
- McCabe, J. (1999) *Paper*. London: Granta Books.
- McEwan, I. (2005) *Saturday*. London: Jonathan Cape.
- McEwan, I. (2010) *Solar*. London: Jonathan Cape.
- Mawer, S. (1997) *Mendel's Dwarf*. London: Doubleday-Transworld Publishers Ltd.
- Mieville, C. (2009) *The City and the City*. London: Pan Macmillan.
- Nelson, R. (2006) "Practice-as-research and the Problem of Knowledge". *Performance Research* [online]. 11 (4), pp.105-116. Available from: <http://dx.doi.org/10.1080/13528160701363556> [30 October 2014].
- Page, R. (Ed.) (2011) *Litmus: Short Stories from Modern Science*. Manchester, UK: Comma Press.
- Roberts, A. (2000) *Science Fiction*. London: Routledge.
- Rohn, J. (2010) *The Honest Look*. New York: Cold Spring Harbor Laboratory Press.
- Russell, N. (2009) "The New Men: scientists at work in popular British fiction between the early 1930s and the late 1960s". *Science Communication*. 31 (1), pp.29-56.
- Saris, F. (2006) *Science through the looking glass of literature* [online]. Available from: <http://www.lablit.com/article/90> [25 October 2009].
- Shelley, M. (1993) [1818] *Frankenstein: Or, the Modern Prometheus*. Hertfordshire: Wordsworth Editions.

- Sleigh, C. (2011) *Literature & science*. Hampshire: Palgrave Macmillan.
- Stephenson, N. (1988) *Zodiac*. New York: The Atlantic Monthly Press.
- Turney, J. (1998) "Public visions of genetics". *Public Understanding of Science*. 7 (4), pp.343-8.
- van der Laan, J.M. (2010) "Frankenstein as science fiction and fact". *Bulletin of Science, Technology & Society* [online]. 30 (4), pp.298-304. Available from: <http://bst.sagepub.com/content/30/4/298> [3 September 2010].
- Wells, H.G. (2005) [1896] *The Island of Doctor Moreau*. London: Penguin Classics.
- Wolpert, L. (1997) "In praise of science". In: Levinson, R. and Thomas, J. (Eds.) *Science Today: Problem or crisis?* London: Routledge, pp.9-21.
- Wray, J. (2013) "Ursula K. Le Guin, The Art of Fiction (No. 221)". *The Paris Review*. Issue 206, Fall. Available from: <https://www.theparisreview.org/interviews/6253/ursula-k-le-guin-the-art-of-fiction-no-221-ursula-k-le-guin> [6 September 2017].

About the Author

Sean Fitzgerald holds a PhD in creative writing from the University of Winchester. His practice considers the writing of science as fiction in the form of speculative stories, and can be read in *Holdfast Magazine*, *The Honest Ulsterman*, *The Ham* and *Written Tales*. An experienced media practitioner and academic, his most recent work, "The fictional scientist as a dichotomy of good and evil in contemporary realist speculative fiction", can be found in *A Shadow Within: Evil in Fantasy and Science Fiction*, from Luna Press Publishing. A debut fiction collection is scheduled to be published late summer 2020.