The Dissertation Committee for Jiin-Yu Chen Certifies that this is the approved version of the following dissertation:

Contextualizing Science: Examining Science's Moral and Social Dimensions Using Virtue Ethics and the Humanities

Committee:

Howard Brody, M.D, Ph.D., Mentor and Chair

Jason Glenn, Ph.D

Anne Hudson Jones, Ph.D.

David Niesel, Ph.D.

Jeremy Sugarman, M.D., M.P.H., M.A.

Cary W. Cooper, Dean, Graduate School

Contextualizing Science: Examining Science's Moral and Social Dimensions Using Virtue Ethics and the Humanities

by

Jiin-Yu Chen, B.A.

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Dedication

To Mom, Dad, Mooney, and Austin

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Science and society share considerable relationships, with each shaping course of the other. Because of this, scientists have a responsibility to reflect upon their work's social and moral dimensions when producing knowledge. Placing science within a virtue ethics framework highlights critical features for developing a contextualized and reflective science. Virtue ethics focuses on cultivating character, drawing attention to the role of the scientist's character when producing scientifically sound knowledge and contextualizing her work. *Phronêsis*, or practical wisdom, helps the scientist discern a virtuous path through the multitude of options, emphasizing the importance of examining the situation from multiple perspectives and attending to the situation's particular nuances. Reflective practice and moral imagination elaborate upon *phronêsis.* Reflective practice discusses how practitioners reflect upon their work by noticing small details, taking the context into account, and adjusting accordingly. In seeing the situation from other perspectives and in discerning a virtuous path, the scientist exercises moral imagination. The humanities can serve as a rich resource for cultivating these skills and exploring science's contexts. Examining figures of the scientist begins to outline features of the public's contradictory relationship with science and how scientists are positioned within that contested space.

The figure of the ordinary scientist shows how frameworks can color how scientists approach and interpret their work. The mad scientist highlights how the scientist's reflection on his work's consequences is a critical factor in evaluating whether it is acceptable or not. And the heroic scientist demonstrates the need for closely reading how the characters are constructed, with the heroic scientist sharing many characteristics with the mad scientist, but are presented favorably. Taken together, these figures illustrate some features of the public's relationship with science and demonstrate how the scientist's character is a critical factor for practicing a contextualized and reflective science. Recent developments suggest science's movement towards incorporating these issues into scientific practice. Translational science, which emphasizes interdisciplinary teams and community engagement, coupled with the requirement for trainees receiving federal funding to take responsible conduct of research courses highlight this shift. Developing a humanities-informed training program can further cultivate a contextualized science.

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Preface

My interest in the intersections between science and society, the role of the scientist's character, and what the humanities can contribute has grown in fits and starts since at least the beginning of my graduate school career. It is difficult to pinpoint when I started on the path that eventuated in this work. It might have been when I started to notice the seeming disconnect between how scientists carry out the daily functions of their work without tending to their larger social and moral dimensions, as I observed when interacting with scientists and then attending my graduate seminars. Or it might have been when I came across reports of scientific misconduct and reports of science's promising innovations, both in a seemingly endless stream. Or when I was puzzling through what the humanities can contribute towards making science a more responsible and reflective practice as I prepared for my qualifying exams. Or I may have started on this path when I worked as a research assistant before graduate school and I was more interested in figuring out what exactly science is and how it is situated within its social and moral dimensions, instead of doing the experiments or interpreting the data in front of me. Undoubtedly, some of my interest stems from being married to a biophysicist, who has not only helped me with the scientific details of my work, but who has also helped to inform and clarify my understanding of the practice of science, what values it holds dear, and where its blind spots may lie. In this case, hindsight is not 20/20, only revealing that this work started as a nebulous interest in examining the practice of science and its social and moral dimensions, and was slowly developed and refined, over the course of my graduate school career.

The purpose of this work is to begin a conversation about how the scientist can craft a practice of science that is reflective upon its social and moral features. In it, I explore how scientists have obligations to examine these features and argue that examining these features should become part of what it means to practice science well. I use virtue ethics as a framework for working through science's moral and social dimensions, where I discuss how the scientist's character is critical in developing a science that is reflective upon its contexts and how the cultivation of *phronêsis*, or practical wisdom, is essential when contextualizing science and deciding how to proceed. I further elaborate upon *phronêsis* by supplementing it with the perspectives brought by reflective practice and moral imagination.

I argue that the humanities can serve as a rich resource for helping scientists cultivate *phronêsis* and explore their work's contexts. Examining the character of the scientist in literature and history begins to outline features of the public's contradictory relationship with science and how scientists are positioned within that contested space. I discuss how the figure of the ordinary scientist shows how character and frameworks can color how scientists approach and interpret their work. The mad scientist highlights how the scientist's reflection on his work's consequences is a critical factor in evaluating whether it is acceptable or not. And the heroic scientist demonstrates the need for closely reading how the characters are constructed, with the heroic scientist sharing many characteristics with the mad scientist. However, instead of prompting fear and revulsion as the mad scientist does, these characteristics are inverted and presented favorably in the heroic scientist. Taken together, these figures illustrate some features of the public's relationship with science and demonstrate how the scientist's character is a critical factor for practicing a contextualized and reflective science.

Recent developments suggest science's movement towards incorporating these issues into scientific practice. Translational science, which emphasizes interdisciplinary teams and community engagement, coupled with the requirement for trainees receiving federal funding to take responsible conduct of research courses highlight this shift. Developing a humanities-informed training program can further cultivate a contextualized science.

I still have not figured out exactly what science is and what all it entails, but this work is the representation of a journey of exploration and reflection on the practice of science, the role of character in practicing science, and how the humanities can complement the scientific enterprise. It is hopefully the beginning of a long and enduring conversation.

Chapter I: Science as a Moral Enterprise

Sitting in a study space on campus, listening to my online Pandora station pipe in Foster the People's "Pumped up Kicks," I cannot help but reflect on the innumerable ways developments in science and technology function as key components in my daily life. From my laptop and the programs it houses that are central to the writing of this work, to the glasses I wear that enable me to see the world, to the developments in fuel and energy production that power my car, my computer, and my shelter, my life would be radically different without the developments science and technology have made over the past several hundred years. And the extent to which science and technology have given rise to the present shape of my life is characteristic of many people today. Even when limiting ourselves to developments in science and technology since the nineteenth century, nearly every corner of daily life has been shaped to some extent by science's hand. Many of these scientific developments are welcomed. People enjoy, or at least would rather not live without, the computers and the internet that have become such central features of their lives, extending their capacities for computing, learning, organizing, and communicating, amongst other things. And while these features of life today are largely inescapable, when the various bits and pieces of science's effects on daily life are put together, they carry significant ramifications that extend beyond any one scientific or technological development. As science has been rapidly increasing in size and scope for the past several centuries, and seemingly exponentially since the nineteenth century, society as a whole has increasingly adopted a scientific framework in interpreting and interacting with the world. That is, in addition to its products, science has also had the effect of causing us to approach nonscientific spheres of our world from a scientific framework. This side effect of science has significant consequences for the shape and direction of our society, which include what problems we consider to be problems, what questions we consider worthwhile questions to ask, and what types of knowledge we deem legitimate in answering them. In this chapter, I will discuss some of the ways the practice of science has altered seemingly nonscientific areas of society, through its products and its methods, the ways society has altered the practice of science, and why scientists have an obligation to society to reflect deeply upon science's future directions and potential implications.

Over the past several hundred years, science has sought to understand and interpret natural phenomena according to knowable physical laws through observable, reproducible experimentation. In this endeavor, it has had great success. Using its methods, the scientific knowledge generated has led to technological developments, which then work to further deepen scientific knowledge about the natural world. Working in tandem, developments in science and technology have produced a dazzling array of discoveries and products that have significantly shaped the course of humanity. Some of science's and technology's accomplishments stand as triumphant symbols of human progress, such as defying gravity through flight, sending a man to the moon, and developing protection from deadly contagious diseases through vaccines. Other accomplishments have become so well enmeshed within daily life that they cease to be thought of as marvelous, but instead as perfectly routine and ordinary. These, such as delivery of clean water, widespread use of the telephone, and extension of food life through refrigeration, are often unacknowledged, yet crucial, developments that have significantly shaped the ways we order and live our lives.

Given the general widespread support of furthering science and technology, the present and future developments in science and technology will continue to substantially alter the course of humanity. Because of the multitude of implications science and technology may bring for our present lives and future, these developments deserve to be closely examined regarding what kind of effects they impart and how those effects are imparted.

Discussion about the effects of science tends to focus on how the knowledge produced is used. Generally speaking, the practice of science is held to be a morally neutral enterprise. Science is thought to generate factual knowledge about the natural world, merely informing us about how the natural world functions, uncolored by bias or interpretation. The achievements of its laborers can be used with ill intent or with good will, but the product itself is seen as neutral. Thus the airplanes, refrigerators, germ theory of disease, and methods of water purification are thought to stand as impressive but morally neutral forms of scientific knowledge or technology. From this perspective, the moral features of science come into play when discussing the possible uses of that scientific knowledge, which could be good, like using the germ theory of disease for vaccine development, or bad, like using the germ theory of disease for developing biological weapons. Thus it is not the knowledge that carries moral weight, but the intent and purpose of those using that knowledge. Science gives us raw power, but it is the people who use science who are seen as moral or immoral, not the practice or the knowledge.

Blurring the Distinctions between Science and Society: Science's Influence on Society

However, the influence science imparts on society is much more than deciding how its products may be used for good or bad purposes. As science produces additional knowledge, society is reshaped and rearranged to further promote science's efforts. With such a relationship, science's moral dimensions extend beyond solely considering how the knowledge is used. Science's findings, its methods, and its values exert influence on nearly every sphere of human activity today; it shapes the way we interpret nature and ourselves. The entire practice of science, including its values, norms, and purposes are morally salient. About how the practice of science encompasses more moral features than simply the use of scientific developments, Yuval Levin writes, "Modern science is a grand human endeavor, indeed the grandest of the modern age. Its work employs the best and the brightest in every corner of the globe, and its modes of thinking and reasoning have come to dominate the way mankind understands itself and its place. We must therefore judge modern science not only by its material products, but also, and more so, by its intentions and its influence upon the way humanity has come to think. In both these ways, science is far from morally neutral."[1] Because the relationship of both science and technology with progress assumes a position of authority in our society today, the implications of science and technology bear increased ethical significance and moral weight. Thus, in addition to how the knowledge is used, science's moral features include how it has changed the way we think, the way we approach and shape the world.[2]

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[1] Yuval Levin, "The Moral Challenge of Modern Science," *New Atlantis*, no. 14 (Fall 2006), 33.

[2] In explaining this shift in perspective, Bruno Latour argues that much of science's power stems from its capacity to make the world an extension of the laboratory. Latour uses the example of Pasteur's demonstration at Pouilly-le-Fort where Pasteur showed a group of farmers, politicians, and townspeople that he could protect livestock from anthrax through vaccination. Latour posits that in order to convince the skeptical public of this, Pasteur blurred the distinctions between the lab and the farm. He brought the bacteria from the farm to his lab where he then magnified and manipulated it to develop the vaccine, and then took his demonstration to the farm to convince the skeptics. By blurring the outside-inside dichotomies of the laboratory and the farm and presenting the outsides and the insides of those spaces as equivalent, Pasteur was able to export scientific principles out of his lab, to great success. His success was

Some of the most notable and pervasive instances of how science has changed the way we approach the world are exemplified through looking at the social dimensions that are interwoven in conceptions of biology and heritability with the Human Genome Project. Unfortunately, I will be able to give only a cursory examination of this fraught and complex relationship because an in-depth discussion of that relationship is beyond the scope of this work. However, my brief sketch will demonstrate the multifaceted and continued influence exerted by scientific principles over how we interpret ourselves and our world, in both scientific and nonscientific areas of society.

Formally started in 1990 and completed in 2003, the Human Genome Project was a large-scale international collaboration between several organizations that aimed to identify the genes in DNA and the base pairs that compose those genes and planned to make the knowledge gained widely accessible.[3] Through understanding the human genome, greater understanding about the relationship between heritability and disease causation was thought to eventuate, resulting in potential therapies. The Project could also lead to advances in molecular biology, both in knowledge about cellular processes and in

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possible because "[s]cientific facts are like trains, they do not work off their rails. You can extend the rails and connect them but you cannot drive a locomotive through a field." For scientific facts to work in the outside world, the outside world must come to mimic the laboratory. Thus Latour argues that science gained its foothold by changing the world into conditions that are hospitable to science's methods. From Bruno Latour, "Give Me a Laboratory and I Will Raise the World," in *Science Observed: Perspectives on the Social Study of Science*, ed. Karin D. Knorr-Cetina and Michael Mulkay (London, UK: SAGE Publications, 1983), 155.

[3] U.S. Department of Energy Office of Science, "Human Genome Project Information," *US Department of Energy Genome Program*, last modified July 31, 2012, accessed September 11, 2012, http://www.ornl.gov/sci/
techresources/Human_Genome/home.shtml.

techniques and technology. Enormous amounts of resources, in terms of both funding and human-hours, were poured into completing the Human Genome Project.

Arguably, however, other unacknowledged but powerful motivators of the Human Genome Project propelled it, demonstrated through the metaphors used to describe DNA, which encapsulated the hopes for what the Human Genome Project might accomplish. DNA was likened to a type of code, a blueprint, a cookbook, or even the Holy Grail. The human genome has been compared to Mendeleyev's periodic table of the elements, that key table that brought order and structure to the multitude of irreducible chemicals. In a similar sense, sequencing the human genome was anticipated to "ultimately reveal the fundamental properties of all human genes, allowing their functions and interactions to be integrated into a miraculously complete picture of human biology and evolution."[4] Scientists hoped that through identifying the various parts of human DNA and cataloguing them, some sort of fundamental, basic truth about humans and our structure would be revealed. Answers about how we came to our present state and what it means to be human are thought to have biological underpinnings housed in our DNA. Through this view, the human condition becomes primarily interpreted as a biological one. This focus upon a biological interpretation of the human condition leads to searching for biological solutions to issues that also have environmental and social components.

Because of the range of variability among individuals' DNA, inherent in the Project are assumptions about normalcy and the acceptable range of deviation from that normalcy.

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[4] Kevin Davies, "Knights of the Double Helix: The Quest for Biology's Holy Grail," in *Cracking the Genome: Inside the Race to Unlock Human DNA* (Baltimore, MD: Johns Hopkins University Press, 2002), 14.

From these assumptions and their potential to define the boundaries of the normal, acceptable human experience, Richard Lewontin speculates that "the importance of the Human Genome Project lies less in what it may, in fact, reveal about biology, and whether it may in the end lead to a successful therapeutic program for one or another illness, than in its validation and reinforcement of biological determinism as an explanation of all social and individual variation. . . . A medical model of all human variation makes a medical model of normality, including social normality, and dictates that we preemptively or through subsequent corrective therapy bring into line anyone who deviates from that norm."[5] What Lewontin fears is that the Human Genome Project propels science towards becoming overly deterministic, that science will eventually claim to be able to explain all facets of human life. The biological explanations for various differences will result in biological definitions of normality. Biological solutions for those who deviate from the normal would be devised without reference to or consideration of the multitude of other pertinent components, such as the contributions of social or environmental factors and their relationships. Thus health and disease would be defined strictly in biological terms and solutions to disease would be primarily biological without an accompanying restructuring of the relationships between that disease's biological, social, and environmental factors which contribute to its occurrence. And from this biologically deterministic standpoint, the bulk of the blame can be laid upon the individual for developing particular diseases, absolving the various societal, political, or environmental factors as also contributing to that disease's occurrence.

[5] Richard C. Lewontin, *Biology as Ideology: The Doctrine of DNA* (London, UK: Penguin, 1992), 65.

This tendency to find biological explanations and solutions for a wide variety of phenomena with social and environmental components is not a recent occurrence, but a continuation of trends that extend back at least a century. In the early twentieth century, ideas about social progress through scientific means became popular, in a wide variety of areas such as eugenics and industry. The present concern about an overreliance on genetic explanations has roots in the eugenics movement and its aftermath of the early twentieth century. Eugenics (the term was coined by Francis Galton in 1883) aimed to deliberately shape the genetic composition of a population based on conceptions of hereditary worth, through encouraging certain people possessing desirable traits to reproduce and discouraging or preventing those possessing undesirable ones from reproducing.[6] Many traits, physical as well as those of temperament, habit, and personality, were argued to be genetically inherited from one's parents. It viewed characteristics, such as intelligence and physical ability, as solely determined by one's genetics. It also included other characteristics, such as alcoholism and various personality traits, as heritable traits. Those with desirable intelligence, personality traits, and physical ability were encouraged to produce offspring, who were assumed to inherit those capabilities. And those who were alcoholics or possessed other undesirable traits or suboptimal capabilities were discouraged, or even prevented, from reproducing.[7] Thus this type of genetic determinism, these explanations for human characteristics, tendencies, and values as heritable, became a driving force in shaping popular thought and social policy. And while eugenics fell out of favor in the

[6] Robert Jay Lifton, *The Nazi Doctors: Medical Killing and the Psychology of Genocide* (New York, NY: Basic Books, 1986), 24.

[7] Ibid., 42.

aftermath of Nazi Germany and the Holocaust, it was ardently pursued worldwide by many preeminent scientists of the day who saw solutions based in science as the way to making a better society, and some of its effects hang as problematic specters for the implications of the Human Genome Project.[8] Some of the present concerns about the Project are that it pushes us closer towards a biologically deterministic view of human nature, that it excludes the various social and environmental factors that also affect human capabilities as it redefines acceptable ranges of individual variation, health, and disease in biological terms.

In a seemingly unrelated area, as eugenics became increasingly popular at the beginning of the twentieth century, other nonscientific areas of society refashioned themselves according to a scientific worldview by adopting science's methods and values. Industry remodeled itself on scientific principles and created systems of scientific management in an attempt for efficiency. With industry, science exerted its influence through adoption of science's approach to understanding systems. To understand complex living systems, science often takes a reductionist approach, where the system is broken down into its individual components, with each studied separately. With this approach, "it is believed that the whole is to be understood *only* by taking it into its pieces, that the individual bits and pieces, the atoms, molecules, cells, and genes, are the causes of the properties of the whole objects and must be separately studied if we are to understand complex nature."[9] This scientific approach reasons that the whole is best understood

[8] Kenneth L. Garver and Bettylee Garver, "The Human Genome Project and Eugenic Concerns," *American Journal of Human Genetics* 54, no. 1 (January 1994): 150-155.

[9] Lewontin, *Biology as Ideology*, 12.

through examining its various parts. Once those individual parts are understood, they merely need to be put back together, in a way much like a jigsaw puzzle, in order to fully comprehend the whole.

In the early twentieth century, industry remodeled itself in a way that was analogous to science's reductionist approach in understanding living systems, where systems of labor were closely scrutinized and broken into their component parts, measured and quantified, with particular solutions aimed at improving particular parts. Advocated by Frederick Taylor, scientific management for an industry meant it was organized "on proven fact (e.g., research and experimentation) rather than on tradition, rule of thumb, guesswork, precedent, personal opinion, or hearsay."[10] Scientific management of a business analyzed and synthesized workflows and restructured the systems of labor to reap the maximum amount of efficiency, which meant producing the maximum profit from each area and laborer. Scientific management for industry and business included measuring the amount of time needed to complete a particular task and then reorganizing the labor and system to decrease the time needed and to maximize the number of tasks that could be completed in a shift. Thus, with scientific management, an industry's main priority became maximizing efficiency and profit, perhaps at the expense of other concerns, such as worker safety, morale, and product quality. Taking science's approach of dividing complex biological

[10] Edwin A. Locke, "The Ideas of Frederick W. Taylor: An Evaluation," *The Academy of Management Review* 7, no. 1 (January 1982): 14. For additional reading about scientific management, Frederick Winslow Taylor's *The Principles of Scientific Management* (New York, NY: Harper & Brothers, 1915) is a good place to start. It is available online as a Google book at http://books.google.com/books?id=zKavkwr0uU4C&printsec=frontcover&dq =taylor+principles+of+scientific+management&hl=en&sa=X&ei=KhQGT9PDGMfL0QHq8rmrBA&ved=0CD8Q6AEwAQ#v=onepage&q&f=false.

systems into their various components, industry compartmentalized its systems into discrete areas and rearranged them for maximum efficiency. Thus, sectors of society that were initially unrelated to science began to adopt a scientific view, by incorporating science's methods and principles into their structure. In addition to increased profits, this move allowed industry to cast itself as progressive by aligning itself with scientific practice, while also bolstering science's growing authority.

The examples of the Human Genome project, eugenics, and scientific management illustrate how pervasive the scientific perspective has become, with previously nonscientific areas of society incorporating science's methods and values into their practice. Taken to an extreme, this approach may lead to *scientism*, the belief that science and its methods produce the most authoritative and accurate worldview, using scientific means to solve social problems.[11] Scientism includes using science's authority, through language or methods, to add weight to arguments as a way of advancing them. In this sense, scientism "implies an *attitude to science:* those who use scientistic language acknowledge and respect *the authority of the scientific community*, and wish to capitalize on that authority, in order to make their discourse more persuasive."[12] With scientism, science becomes the most authoritative, most reliable way of generating knowledge for all areas and is further perpetuated when using science's authority to bolster a certain perspective or belief. Science, through its products and its perspectives, inevitably shapes society and while allegations of scientism are usually criticisms, how and why science is brought to

[11] Gregory R. Peterson, "Demarcation and the Scientistic Fallacy," *Zygon* 38, no. 4 (December 2003): 752.

[12] Iain Cameron and David Edge, *Scientific Images and Their Social Uses: An Introduction to the Concept of Scientism* (London, UK: Butterworths, 1979), 3.

nonscientific spheres must be closely examined. Were eugenics and scientific management demonstrations of scientism? The proponents of eugenics relied on scientific knowledge as justification when shaping the composition of a population, by believing knowledge derived from science would be able to rid society of its unwanted members and by using the authority of science to support their actions. Similarly, advocates of scientific management believed in science's reductionist framework as profitable for reorganizing labor systems and bolstered industry's image by drawing upon science's growing authority. Eugenics seems to be a clearer demonstration of the inappropriate use of science for changing society, whereas scientific management is less clear. Application of eugenics to the population precipitated horrific loss of lives. The reorganization of labor structures seems to be more amenable to science's methods than controlling a population's composition, but treats the workers as interchangeable objects to be moved about, not as autonomous actors. A fine balance must be found that allows science's methods to alter society in ways that do not veer into an overreaching scientism.

Blurring the Distinctions between Science and Society: Society's Influence on Science

If science functions as a significant contributor to how we frame and inhabit our world, in particular with the adoption of scientific methods and values into previously nonscientific sectors of society, then what of society's influence on the shape and direction science takes? Before I can address this question, I must first look at why this was once a controversial question. I must examine why a conception of science as isolated from and unaffected by social forces existed and how that conception affected the practice of science.

The idea of science as unconnected to social forces became popular with the rise of positivism in the early to mid-twentieth century and was pervasive through the natural and social sciences. Positivism held that science is always value-neutral and true knowledge is attained in only very specific (scientific) ways. More specifically, positivism claimed that acceptable knowledge was generated only through scientific reasoning, that these knowledge claims are quantifiable, that science and its methods can explain all phenomena, and that science contains no value judgments.[13] From a positivist perspective, science and its methods can reveal ultimate, objective truths about phenomena, truths that are unblemished by any individual or societal values. Positivists held that science's task of explaining phenomena through universal, timeless principles was possible only when following science's rigorously objective methods and divorced from any reliance on values or unquantifiable factors. This perspective resulted in the devaluing of knowledge not discernible through science's methods and in believing that good science operates unaffected by values, biases, or other subjective factors, such as society. Science became constructed as an activity that operated unaffected by society, producing the most authoritative, reliable form of knowledge.

Positivism in science enjoyed its heyday from post-World War II to the 1970s, but then slowly began to lose traction as critics increasingly argued against the image of science as isolated from society. Taken together, these voices articulate how science is very much shaped by society. Thomas Kuhn, in discussing science's abandonment of one framework for another, characterizes features of "normal science" that operate within established

[13] Jeffrey Burkhardt, "Scientific Values and Moral Education in the Teaching of Science," *Perspectives on Science* 7, no. 1 (Spring 1999): 98.

"paradigms." By this, he means "research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the foundation for further practice," where the "coherent traditions of scientific research" are demonstrated through "law, theory, application, and instrumentation."[14] Although, the majority of science occurs within accepted paradigms, these paradigms are occasionally discarded and new ones adopted, resulting in a scientific revolution. What precipitates the adoption of a new paradigm is the detection and recognition of a phenomenon that does not fit within the prevailing paradigm. Paradigm shifts are characterized by "the previous awareness of anomaly, the gradual and simultaneous emergence of both observational and conceptual recognition, and the consequent change of paradigm categories and procedures often accompanied by resistance."[15]

Normal science within old and new paradigms and revolutionary science between paradigms are inherently value laden and products of their makers' contexts. Although a new paradigm might look at the same object as the old paradigm, "in some areas they see different things, and they see them in different relations one to the other."[16] That is, science practiced in paradigms does not provide an unfiltered, neutral window into the workings of the natural world. Instead paradigms function as lenses through which scientists evaluate various systems, methods, and questions as worthy of scientific investigation, setting the rules scientists follow. Taking Kuhn's ideas further, Steven Rose

[14] Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 3rd ed. (Chicago, IL: University of Chicago Press, 1996), 10.

[15] Ibid., 62.

[16] Ibid., 150.

and Hilary Rose argue that social forces, in part, constitute the paradigms for normal science, thus directing the knowledge produced. They argue that paradigms are inherently value laden and socially constituted. Comparing the metaphors used for the cell in the 1930s (energy, currency, economy) with those used in the 1950s (control, community, repression), these differences reflect the concerns of the social climate of the time and "frame too closely the thought process of the researcher."[17] Social conditions, in part, determine the metaphors the scientist uses to structure her work, thus shaping the questions and methods she deems appropriate. The language and the metaphors scientists use reflect the values and perspectives that frame their research questions.

From a somewhat different perspective, Philip Kitcher argues that society's influence on science is evidenced through its role in reflecting and shaping the concerns of its age. Kitcher argues that the categories and classifications science draws are inherently value laden, where the classifications are "embedded in a network of institutions, laws, and artifacts, but they also foster self-conceptions that excite or inhibit actions. The resultant pattern of human activity can then easily reinforce the judgment that the initial classification marks an important natural division."[18] The lines science draws when dividing up the world for study are reflective of social issues of the time, and the work produced and the actions that precipitate from these divisions can further sustain them. And while these divisions and their effects may hold fortunate or unfortunate consequences for both science and society, Kitcher argues this intertwining of science and society, of how

[17] Steven Rose and Hilary Rose, "The Myth of Neutrality of Science," in *The Social Impact of Modern Biology*, ed. Watson Fuller (London, UK: Routledge & Kegan Paul, 1971), 222.

[18] Philip Kitcher, *Science, Truth, and Democracy* (Oxford, UK: Oxford University Press, 2001), 52.

science's directions draw from social concerns, is how science should operate. That science is shaped, at least in part, by society is not a regrettable flaw, but an important component of how science functions. Because science existing as isolated from society is a myth, science must be attentive to its relationship with society. It should "address the issues that are significant for people at a particular stage in the evolution of human culture," and "what counts as significant science must be understood in the context of a particular group with particular interests and with a particular history."[19] Good science includes being responsive to the needs of its day whose shape and directions are understood within its various contexts.

Helen E. Longino's analysis of the relationship between science and society further fleshes out how science is not the value-neutral practice that positivists imagine, but is instead very much socially constituted. She argues that the acceptable ways of connecting data with a hypothesis only make sense only against the backdrop of assumptions and contexts from which the scientist operates. She contends that the reasoning used in the sciences "is always context-dependent, that data are evidence for a hypothesis only in light of background assumptions that assert a connection between the sorts of thing or event the data are and the processes or state of affairs described by the hypothesis. Background assumptions can also lead us to highlight certain aspects of a phenomenon over others, thus determining the way it is described and the kind of data it provides. Background assumptions are the means by which contextual values and ideology are incorporated into

[19] Ibid., 59, 61.

scientific inquiry."[20] Among the background assumptions needed to connect data with a hypothesis is not only the relevant scientific knowledge, but also the values and ideologies that give rise to the shape of that data and hypothesis. In bringing together the various arguments for science as value laden, not value-neutral, from Kuhn's paradigms, Rose's and Rose's scientific metaphors, Kitcher's socially responsive, contextualized science, and Longino's socially informed background assumptions, one can see how society has significant bearings on the way science is interpreted, understood, and directed, where science functions in response to its larger social contexts. This context dependent feature is not a flaw to be eliminated as the positivists would seek to do, but critical to the furthering of good science.

Scientists' Social Responsibility

While any sort of strong positivism is largely held in disrepute, one of its lingering effects is the general failure to reflect upon science's social and moral features by many scientists. Such reflecting is still largely seen as outside the scope of what scientists do. Reflection upon science's context may be seen as illuminating and admirable when done, but it is not critical to the production of scientific knowledge. Consequently, science generally is reluctant to reflect upon its own moral and social features. In what he calls "the myth of accountability," Daniel Sarewitz attributes this reluctance to the belief on science's part that its social contract encompasses only benefits for the public in the form of scientific and technological advancements: "This is the myth of accountability: that

[20] Helen E. Longino, *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry* (Princeton, NJ: Princeton University Press, 1990), 215-216.

internal integrity equals external responsibility; that the ethical obligations of the research system begin and end with the delivery of a scientific product that is quality controlled and intellectually sound."[21] From this perspective, science is responsible only for producing scientifically and technically sound knowledge and products, not for how they affect society. Science, while dependent upon societal support, is freed from responsibility towards society once its products are open to society. Science becomes isolated and insulated from taking its consequences into account when developing its research framework and directions. Thus, society is unable to participate in science's directions, while science is excused from examining its own moral features.

Because of positivism's legacy, much of science's social context and moral features are often overlooked by scientists because those issues are thought to be outside the scope of legitimate science. Scientists are often thought of as highly trained, neutral conveyers of truth about the natural world. Since the value-laden thoughts and questions about how scientific knowledge should be used are subjective, they are considered somewhat tangential to the scientific realm. Some believe the decisions about how scientific knowledge should be used appropriately stem from other societal spheres, such as policy, law, and ethics. The relationship between science and society can be likened to a one-way street. Science generates knowledge for society's use but without much reflection upon its potential uses: "the dictum 'science proposes, society disposes' suggests, such decisions are in hands of politicians, generals, medical doctors, firm owners, etc. . . . The issues of use, misuse, or dual use research are not problems to be dealt within science; a scientist's taking a stance on

[21] Daniel Sarewitz, *Frontiers of Illusion: Science, Technology, and the Politics of Progress* (Philadelphia, PA: Temple University Press, 1996), 58.

such problems would be considered unprofessional. Of course, scientists might serve as government experts, members of ethical committees, or religious leaders, but then they pass evaluative judgments while playing a social role different than a researcher."[22] Moral and social considerations are regarded as outside the scope of legitimate scientific practice and scientists are thought of as ill-positioned to discuss science's moral matters.

Stated another way, this lack of reflection by scientists may stem from science's inability to adequately address most moral questions using its tools and methods. In seeking to explain natural phenomena through physical laws based on observable, reproducible experimentation, science's methods are quite good. But in addressing how science functions within its larger social context, including reflecting upon science's moral features, its methods, which focus upon producing unequivocal, universally generalizable knowledge about the natural world, are unable to satisfactorily address moral issues, which deal with questions of what we ought to do and what values and frameworks we need in order to reach that ought. By and large, complex moral issues are not unequivocal and are extremely difficult (if not impossible) to satisfactorily discuss solely through universal principles, quantification, and science's reductionist framework. Because satisfactory discussions of moral issues are not amenable to science's methods, practitioners of science are sometimes uneasy in attending to science's moral issues and unwilling to offer suggestions that guide the development and use of scientific knowledge and technology.

Scientists are trained to produce good scientific work, such as reliable, reproducible data, reasonable interpretations of that data, and theories that explain their data within its

[22] Agnieszka Lekka-Kowalik, "Why Science Cannot Be Value-Free: Understanding the Rationality and Responsibility of Science," *Science and Engineering Ethics* 16, no. 1 (2010): 34.

larger scientific context. And while some in the scientific community may have an interest in contextualizing science or exploring its moral features, they are not trained to grapple with the uncertainties, ambiguities, and contingencies that are intrinsic to many moral issues. And because science, with its authority and power as a primary speaker of truth in society today, is unable to satisfactorily address moral questions, these questions are generally left unexamined by practitioners of science. Science "is a process of inquiry, or asking questions. . . Research in the natural sciences is therefore an effective tool for alerting society to potential problems, but it is intrinsically ill suited for prescribing solutions to those problems."[23] Science asks questions about the natural world and finds answers about the present and past state of things. Science may even construct a future state of affairs for a particular trajectory and suggest how to get there, but it is unable to help us decide which option of several alternatives should be chosen. Even if science's predictive capacities are reliable, those predictions do not go very far in recommending what should be done with them. Simply put, science tells how things are, how they were, and how they might become, but not how they ought to be or how to get there.[24] However, simply because science cannot adequately address its moral issues does not mean those issues do not require attention.

To be fair, this characterization of science's relationship with society and how scientists function within it is a bit of a simplification. Many scientists recognize science

[23] Sarewitz, *Frontiers of Illusion*, 94.

[24] This is-ought distinction for science and its limits is founded in David Hume's moral philosophy. David Hume, *A Treatise of Human Nature*, Project Gutenberg, bk. 3, pt. 1, sec. 1, last updated March 31, 2012, accessed November 7, 2012, http://www.gutenberg.org/files/4705/4705-h/4705-h.htm. The distinction has been increasingly challenged in recent years, but an in-depth discussion of it is beyond the scope of this work.

and society have significant relationships, including how science has changed the shape and direction of society, and may have their own opinions about how science ought to be used or what avenues of research science should pursue. However, as previously mentioned, these thoughts are usually not offered through their professional roles as scientists, but as fulfilling other social roles, most often that of concerned citizen. But as science has had and continues to have a profound hand in shaping the future and science's moral features are intertwined with scientific practice, scientists' reflection on them ought to be within the scope of legitimate scientific practice. Scientists *qua* scientists, in addition to doing scientifically sound work, ought to reflect upon science's moral dimensions, to contextualize their work within the larger social arena, with the purpose of creating a more ethically responsible scientific practice.

Because of scientists' position within society and their specialized knowledge, some argue that they have significant obligations to practice science responsibly and ethically. Kristin Shrader-Frechette, for example, argues that scientists have an implicit social contract which begins with the training, education, and benefits society affords scientists, where they have the "responsibility to preserve, develop, and extend the intellectual assets that they have received (in part) from the public and that they hold in trust for that society."[25] Vivian Weil argues that scientists' duties stem from this contract, but also grants them "the status and power of scientists as members of a profession, their

[25] Kristin Shrader-Frechette, *Ethics of Scientific Research* (Lanham, MD: Rowman & Littlefield, 1994), 24.

monopolies over information, and the rights of those affected by scientists' research."[26] Through this implicit contract scientists have with society, scientists are granted special freedoms and privileges closed to nonscientists, but they also incur significant responsibilities towards society. Virtually no scientist is trained and does research without societal support, whether by receiving federally funded grants, working at publically funded or subsidized institutions, or by accepting the general societal approval that their work is worthwhile. Scientists retain a monopoly over scientific knowledge, in part because of these benefits. The benefits society afford scientists, the monopoly over scientific knowledge, and the possible far-reaching consequences of their work, all engender an obligation for scientists to use their position and power in a responsible and ethical manner for society. As part of science's social contract, Shrader-Frechette argues that not only should scientists avoid endangering the public welfare, but they should also have responsibilities towards actively promoting its well-being, through abstaining from research likely to harm the public and pursuing research that could yield great benefit. Shrader-Frechette grounds this obligation in society's needs, scientists' ability to significantly affect social changes, their dependence upon society, and the public's investment in research.[27] She argues that scientists have considerable economic, political, and intellectual power, where their special knowledge and monopoly over that knowledge renders society dependent upon them to translate that knowledge into societal benefit.

[26] Vivian Weil, "Making Sense of Scientists' Responsibilities at the Interface of Science and Society: Commentary On 'Six Domains of Research Ethics'," *Science and Engineering Ethics* 8, no. 2 (April 2002): 244.

[27] Shrader-Frechette, *Ethics of Scientific Research*, 64-72.

The social contract framework illuminates some important features of scientists' social responsibilities, namely how dependent science and society are on each other and how the privileges and benefits society grants to scientists engenders social responsibilities. However, scientists may still incur social obligations, regardless of a contractual framework, which are grounded in the very nature of scientific work. Using the metaphor of the relationship between inventor and invention, Stanley Joel Reiser and Ruth Ellen Bulger argue that the act of creation engenders responsibility for the created, for "[w]ithout the active work of a scientist exploring a particular physical property, it would not be known and therefore these actions create responsibilities that are ethically significant. . . . Whoever makes the effort and succeeds in the discovery receives the kudos, but must also accept the responsibility for having done it: not the responsibility that carries blame for anticipated consequences, but the responsibility to be there, to participate, to follow the path the discovery takes and to help society use it appropriately."[28] It is not enough to create knowledge, set it loose in the world, and let others figure out how to use it. Just by producing the knowledge, scientists have an obligation to participate in its interpretation and uptake, easing the transfer of knowledge to society.

While scientists' social responsibility encompasses obligations owed to the present, some argue that the work and consequences of science require scientists to be more far-sighted. Karl Popper argues that "everybody has a *special* responsibility in the field in which he has either *special power* or *special knowledge*. . . . Since the natural scientist has become inextricably involved in the application of science he too should consider it one of

[28] Stanley Joel Reiser and Ruth Ellen Bulger, "The Social Responsibilities of Biological Scientists," *Science and Engineering Ethics* 3, no. 2 (June 1997): 140-141.

his special responsibilities to foresee as far as possible the unintended consequences of his work. . ."[29] The scientist's particular knowledge especially requires the scientist to consider what may result in the future because of her present actions. Extending the argument, Hans Jonas argues that those of the present engender a responsibility towards the future, which is grounded in the present's power over the future's shape and development, its capacity to control how an action develops, and the capacity to foresee, to an extent, the results of that action. For those of the present, because the decisions and actions of those currently alive set the conditions for future persons, the "well-being, the interest, the fate of others has, by circumstance or agreement, come under my care, which means that my control *over* it involves at the same time my obligation *for* it."[30] Thus, because their work holds substantial implications for the directions and shape of the future, scientists also have significant obligations to do their work in a way that helps ensure the development of a desirable future; scientists' power over society's future shape also engenders a responsibility to care for it.

Indeed, in a practical sense, for this kind of work, scientists are in a better position than most in society to understand and reflect upon science's moral features, despite their lack of familiarity with deliberating about science's various moral and ethical features. Because of their technical and theoretical expertise and their position within science, they are better equipped than even an educated layperson to begin deliberating about science's

[29] Karl Popper, "Moral Responsibility of the Scientist," in *Induction, Physics, and Ethics: Proceedings and Discussions of the 1968 Salzburg Colloqium in the Philosophy of Science*, ed. Paul Weingartner and Gerhard Zecha (Dordrecht, Holland: D. Reidel, 1970), 335-336.

[30] Hans Jonas, *The Imperative of Responsibility: In Search of an Ethics for the Technological Age* (Chicago, IL: University of Chicago Press, 1984), 93.

moral features. They have an intimate knowledge of the intricacies of their research, including its directions and predicting its potential benefits and consequences. Additionally, regardless of their specific interests and disciplines, scientists are more familiar with science in general than most people. They live through its day-to-day life and understand how the daily operations function within science's larger technical and theoretical frameworks. From their vantage point within the inner workings of science, scientists are ideally positioned to see what their research and field may hold for society and to see plausible courses of action when attending to science's moral features and social context.

Science is morally fraught in part because of the authority and power it wields in shaping the ways human beings think of themselves and the spaces they inhabit. Its influence is felt not only in how the knowledge and technologies are used, but in how the methods, values, and assumptions that shape those technologies and knowledge have come to shape human perspectives on life in general. The scientific perspective has been brought to bear upon previously nonscientific areas of life, such as determining the characteristics of the social body based upon what traits are genetically heritable. Science's reductionist methods, which seek to understand complex systems through examining their individual parts, have been applied to shaping business and industry models. The boundaries between the scientific and nonscientific spheres of society bleed into each other, with one exerting influence upon the other. The scientific perspective has become the predominant way of viewing not only the natural world, but also society and humanity at large. Science's ways of reasoning and system of values have come to shape what is considered good or valuable in spheres outside of science:

> Science forces itself to consider only the quantifiable facts before it, and using those facts it forms a picture of the world that we can use to understand and overcome certain natural obstacles. The more effectively the scientific way of thinking does this, the more successfully and fully it persuades us that this is all there is to do. The power and success of scientific thinking therefore shape our thinking more generally.
>
> Only when we understand modern science primarily as an intellectual force can we begin to grasp its significance for moral and social thought. The scientific worldview exercises a profound and powerful influence on what we understand to be the proper purpose, subject, and method of morals and politics.[31]

Over the past few hundred years, science has gained immense power as the definitive authority in how the natural world works. Technologies developed from scientific knowledge have changed the course of human history. Science's moral considerations and the imperative to examine them have developed in part from the extension of scientific thinking beyond the scientific realm.

How are we to address the moral complexities that science presents, if science itself cannot? We can turn towards looking at other knowledge traditions which can help us think through science in terms of its moral landscape. Much of science's moral complexities, which might not exist if not for science, are essentially moral questions, not scientific. Understanding the issues as moral in nature creates a space for developing nonscientific ways of thinking through these problems within a largely scientific worldview, helping alleviate science's blind spots in tackling its moral issues. Disciplines within the humanities can serve as valuable resources that can help in the struggle with identifying and

[31] Levin, "The Moral Challenge of Modern Science," 35.

understanding science's moral landscape. Similar to the sciences, the humanities are concerned with understanding the human experience, but from a very different stance, one that approaches the human experience as largely subjective that is not universally generalizable. There may be important shared characteristics amongst most human experiences, but each one has its own nuances and contingencies. Instead of searching for universal truths, the humanities are concerned with examining many facets of the human experience, with providing a multiplicity of voices and perspectives and holding them in tension, with requiring close and careful thinking when navigating through those many, and possibly contradictory, perspectives. The humanities are concerned with close and careful reflection on the many possibilities of the human experience, particularly its moral ones. Each discipline within the humanities has its own methods and perspectives, as well as considerable bodies of research and thought, which can be brought to bear upon science.

Using the humanities, particularly those within academic traditions, to illuminate science's moral landscape will be more extensively discussed in subsequent chapters. For most of this chapter, I have talked about science in a general, abstract way, referring to the entire practice of science and its various disciplines and subdisciplines. For rest of the work, however, I will limit my discussion to biomedical science when working through some of science's moral features. In the remainder of this work, I develop one way the humanities can help scientists deliberate their about work's social and moral features to create a science that is reflective upon and responsive to its context. I place science within a virtue ethics framework to see how virtue ethics can illuminate some of science's moral dimensions and serve as a beginning point for scientists to reflect upon those dimensions and engaging with the humanities. I look at what virtue ethics requires of scientists in developing additional perspectives and contextualizing their work and how they may begin to do this. However, while virtue ethics provides a useful framework for scientists to work within when deliberating its moral dimensions, I also turn to disciplines within the humanities, specifically history and literature, for demonstrating how they can be rich resources for bringing forth some of science's moral features, contextualizing science within its relationships with society, and providing additional perspectives.

To start exploring how the humanities can help scientists reflect upon science's moral and contextual landscape, I discuss virtue ethics and how it may contribute to that reflection. Chapter 2 provides an overview of virtue ethics in the Aristotelian tradition, outlining virtue ethics' focus and requirements and what they entail for the moral agent. I discuss what science within a virtue ethics framework might look like, examining how it can illuminate some of science's moral dimensions and how science may function within that space. I then turn to Alasdair MacIntyre's discussion of virtue ethics and practices to further elaborate what virtue ethics can mean for science, when thinking of science as a type of practice.

In Chapter 3, I focus on one specific virtue, the virtue of *phronêsis*, roughly translated as practical wisdom. I discuss how its cultivation and its various facets are critical in the development of science that is virtuous not only in producing data that are reliable and scientifically sound, but data that are responsibly and ethically derived, that pay attention to their moral and social features. I draw from other schools of thought that share characteristics with *phronêsis*, specifically reflective practice and moral imagination, to develop a robust conception of *phronêsis*.

Chapters 4, 5, and 6 should be read and discussed as a unit, as they draw from each other quite a bit. Although many disciplines within the humanities can provide valuable insight when discussing science's moral features, I use examples from history and literature to show how those disciplines can serve as rich resources for discerning science's moral dimensions. Specifically, in these chapters, I examine public perceptions of the scientist by dividing them into three categories: the ordinary, the mad, and the heroic scientist. I focus on images of the scientist in history and literature, using them to contextualize these figures and their relevance for practicing scientists. As these three images of scientists simultaneously exist in tension with each other, these figures can serve as beginning points for exploring the various moral dimensions attached to each figure and understanding how these images are relevant to their practice of science. From these figures, scientists can begin to explore how science fits within society and understand how their work both shapes and is shaped by forces outside of science. These figures serve different functions in their relationship to the practicing scientist, but taken together help contextualize scientific practice and help the scientist grapple with science's moral landscape.

Chapter 7 describes future directions of scientific practice, examining the turn toward translational science and what it entails for science. It discusses beginning steps taken towards encouraging scientists to reflect upon their work's social and moral dimensions and recent examples of using the humanities in discussions of those dimensions and what a humanities-informed training program for the translational scientist might look like.

The challenges modern science poses are not only questions about how to use the knowledge and technology science produces, but also questions about how science has shaped assumptions and understanding of humans and their world. As the boundaries of science blend into nonscientific areas of society, various sectors of society adopt scientific norms and values and rearrange their structure based on science's framework. Thus, at least in part, science's moral force derives from its ability to convince modern society to adopt a scientific worldview for nonscientific areas of life. With this worldview, science's domain extends into all spheres, natural and humanmade, becoming the most authoritative way of generating knowledge. Scientific practice colors how society recognizes, categorizes, and evaluates the worth of an object, an idea, a method; it affects what society believes has moral weight and it affects how society thinks through the moral features. Further, science itself is composed of various assumptions, biases, and other inescapable subjectivities. Thus, science draws some of its moral complexities from these features, which scientists should explicitly examine. Science's moral features stem not only from the use of its products, but also from the values, assumptions, and methods that provide the foundation for science's products and their use, which color the shape and form of science in the first place. As science has become more powerful, it has altered the direction of society's moral compass. Science's general inattention to its own moral complexities using its methods has resulted in many of those issues remaining unaddressed and unexamined by scientists. Because of science's influence over society and scientists' position within science, scientists have obligations to reflect upon science's moral and social issues, which is critical to the development of scientific knowledge that is responsible, ethically derived, and cognizant of its relationship with society. Because science's moral questions are critical to the shape of the future and ought to be examined, other sources must be searched for their insight.

Chapter 2: Virtue Ethics, *Phronêsis,* and Practice

Many potential approaches are possible when examining what moral features are encompassed by science. Certainly science has a multitude of moral features that scientists ought to reflect upon when developing a responsible and ethical science. Moral concerns permeate virtually every sphere of science, ranging from misgivings over the means and goals of genetic testing and synthetic biology, to issues about authorship and scientific misconduct, to debates about experiments using animal and human subjects. The moral issues scientists face are so wide ranging and multifaceted, that it would be impossible, in any practical sense, to compile a comprehensive list and proscribe what-to-do guidelines for every situation. The variety and sheer volume of issues that the scientist could reflect upon can make the whole task seem terribly overwhelming and unwieldy. To bring some order to such a disparate and scattered jumble of issues, already established ethical frameworks can serve as useful starting points for helping the scientist to work through them. Ethical frameworks can at least bring some structure to examining science's moral features that scientists can use to order their reflections or to react against in their reflections.

To help bring some order to science's multitude of moral features, the scientist is also faced with a variety of options. In this chapter, I begin to outline what a possible relationship might resemble from within a virtue ethics framework. Although other ethical frameworks, such as utilitarianism or principlism, are available and can also be useful in showing some of science's moral features, I will focus solely upon discussing virtue ethics as an ethical framework for science. Although science's moral features vary considerably, they all have in common the fact that they, one way or another, exist because of science, and by extension, because of scientists. Virtue ethics specifically focuses on one's character, how it is contextualized and developed within the moral landscape. Thus for the scientist tackling science's moral features, virtue ethics can function as a useful structure for examining and understanding the scientist's character and how it participates in and contributes to science's moral landscape. I describe virtue ethics from the perspective of two philosophers, Aristotle and Alasdair MacIntyre. Aristotle lays out the general focus of virtue ethics and MacIntyre builds upon it and also reworks it somewhat to discuss how virtue functions within a practice, which is a useful way to understand science, its development, and continuation. I examine how these various conceptions of virtue ethics relate to science and scientists. Although virtue ethics initially may seem to be far removed from the practice of science, housing science within a virtue ethics framework can give us a beginning point for understanding science's moral complexities and ways of addressing them.[1]

Aristotle and Virtue Ethics

Virtue ethics emphasizes the importance of the moral agent's character, arguing that the development and exercise of the virtues over a lifetime are crucial to a life well-lived. It also insists upon understanding actions as contextualized within the situation, paying close attention to its details and contingencies. To discern how virtue ethics can illuminate science's moral features, I will discuss virtue ethics as put forth in *Nicomachean Ethics*, in 350 B.C. by Aristotle, an ancient Greek philosopher whose writings "span a wide range of

[1] Examining science from a virtue ethics framework begins to fill an existing gap in the literature. While there is a growing body of literature that discusses various parts of science's moral features, these works are often arranged topically, such as genetic engineering, relationships between academia and industry, or scientific misconduct. Little literature exists that places science within an ethical framework and examines what features of science that framework highlights.

disciplines from logic, metaphysics and philosophy of mind, through ethics, political theory, aesthetics and rhetoric, and into such primarily non-philosophical fields as empirical biology."[2] Aristotle was among the first to discuss virtue ethics at length and whose conception of virtue ethics continues to provide much of the foundation for current discussions of it.

According to Aristotle, the purpose of virtue is to enable one to reach the *telos*, the ultimate good or end. Aristotle is particularly concerned about the *telos* over a lifetime, the goal of a person's life. Talking about *telos* is a way of talking about a person's conception of a good life, a life well-lived. Specifically, Aristotle holds the *telos* to be *eudemonia*, the happiness that results from the state of being and doing well, often translated as human flourishing. Aristotle argues that there is a reason for doing every action, whether the reason is for the action itself or some product that results from the action, but these actions fit within a hierarchy of ends. The end at the top of the hierarchy is the ultimate good towards which all other subordinate ends work, which Aristotle identifies as *eudemonia*. Thus, for Aristotle's framework of virtue ethics, the overarching *telos* is *eudemonia*, and all other subordinate ends should work to promote its realization. As it is the ultimate good and other ends are subordinate to it, *eudemonia* is complete in itself because "we always [choose it, and also] choose it because of itself, never because of something else" (1097b1-2).[3] Because of this wholeness and because all other ends work together towards *eudemonia*, Aristotle puts forth human flourishing as the *telos*.

[2] Christopher Shields, "Aristotle," *Stanford Encyclopedia of Philosophy*, last modified September 25, 3008, accessed November 7, 2012, http://plato.stanford.edu/entries/aristotle.

[3] Aristotle, *Nicomachean Ethics*, trans. Terence Irwin (Indianapolis, IN: Hackett Publishing, 1985), 14.

Although Aristotle holds that every person's ultimate good is human flourishing, it is typically interpreted in a broad sense, since the ways for people to flourish are numerous. In this broad interpretation, "it is a person's conception of what it is to flourish that he is, if he is fully in control of his life, putting into effect in all his actions: he acts always with a view to living a certain kind of life, which kind of life he regards as a flourishing one."[4] Thus, everyone has her own conception of flourishing that differs from other conceptions. While individual conceptions of human flourishing vary from person to person, similar characteristics are shared amongst most of them, such as a life filled with love, happiness, contentment, and understanding. Presumably, most people want these characteristics in their lives, but differ in how they want to pursue them and what contributes towards achieving them. For example, some people may find contentment through pursuing their hobbies or extracurricular activities, while others may find contentment through excelling in their chosen profession. For a scientist, part of her conception of a life well-lived may include doing science well.[5] Certainly doing science well includes doing scientific work that yields reliable, reproducible, and accurate knowledge that explains natural phenomena. However, as discussed in the previous chapter, science and society have significant relationships and scientists incur responsibilities to reflect upon those relationships. To capture this dimension, a picture of doing science well also includes producing scientifically

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[4] John M. Cooper, *Reason and Human Good in Aristotle* (Cambridge, MA: Harvard University Press, 1975), 96.

[5] While this discussion focuses specifically on how the scientist may function within virtue ethics, I want to note that the moral agent in her role as scientist should not be thought of as separate from the moral agent as a person. Indeed, a key component of virtue ethics is that the moral agent has integrity within her character, that is the moral agent's various social roles and how she carries them out cohere and are broadly illustrative of who she is as a person. However, I focus on the moral agent's role as scientist to show specifically what virtue ethics requires of the scientist.

sound knowledge about the natural world while also attending to science's moral and social features. The picture of doing science well becomes broadened to include reflection upon science's moral dimensions with the intent of creating a science that is sensitive to its context within society. Good science becomes contextualizing one's work to responsibly and ethically produce reliable, reproducible knowledge about the natural world.

For someone to reach her *telos*, she must work towards cultivating virtue. Virtues are necessary for a good life because it is through the virtues that one achieves the *telos*; they allow him to "be in the state that makes a human being good and makes him perform his functions well" (1106a23-24).[6] Aristotle reasons that the activities that express virtue promote happiness and those actions that are contrary to happiness counter it. To elaborate, Scottish philosopher Alasdair MacIntyre writes, "For what constitutes the good for man is a complete human life lived at its best, and the exercise of the virtues is a necessary and central part of such a life, not a mere preparatory exercise to secure such a life."[7] Development of the virtues helps the moral agent reach her vision of the good life; it is central to the pursuit of the *telos*. For the scientist, if her *telos* includes excellence in her scientific work, then she will need to cultivate virtues that enable her to do excellent scientific work. These virtues may include, but are certainly not limited to patience, for scientific work is often tedious and time consuming; courage, for standing by one's results even if they contradict the already established body of literature, and honesty, for admitting one's results are flawed.

[6] Aristotle, *Nicomachean Ethics*, 42.

[7] Alasdair MacIntyre, *After Virtue: A Study in Moral Theory*, 3rd ed. (Notre Dame, IN: University of Notre Dame Press, 2007), 149.

The idea of virtue as central for the *telos* is important because for a person to become virtuous, the various virtues must become part of that person's character, her way of being. Aristotle believes that a person pursuing virtue can only become virtuous through regular and repeated exercise of the virtues. He believes that "we are by nature able to acquire them, and reach our complete perfection through habit" (1103a25-26).[8] Although the virtues may initially be foreign to us, they become part of our character, our way of understanding ourselves and the world through habitual use. They are the habits of being and acting that become ingrained in one's character, which eventuate in the person's inability to act any other way besides the way prescribed by virtue. When the virtues eventually become a part of a person's way of being, the moral agent is able to further pursue her conception of the good life.

As part of ingraining virtue upon character, simply appearing to act virtuously is not enough. To wholly integrate virtues with character, Aristotle argues that the eventual action is only one part of virtue. The moral agent must also do the actions from the proper framework, for the right reasons. Aristotle breaks down the process by describing three steps: "First, he must know [that he is doing virtuous actions]; second, he must decide on them, and decide on them for themselves; and third, he must also do them from a firm and unchanging state" (1105a31-34).[9] The agent must be aware that this is a situation that requires virtue and decide to act virtuously because it is the appropriate action given the situation and the moral agent's character. Thus, in using the virtue of patience for the scientist, should she choose to have patience in seeing a particularly thorny and complex set

[8] Aristotle, *Nicomachean Ethics*, 34.
[9] Ibid., 40.

of experiments to completion, she does so deliberately because she knows it is the right course of action and commits to persevering through the experiments' complications and tedium. She realizes patience will better her chances of producing reliable scientific knowledge, instead of taking shortcuts and rushing through the experiments, which could increase the possibility for error. Through habitual exercise, patience becomes ingrained in her character. The scientist knows she must be patient when doing experiments and comes to bring this approach to all her experiments and science in general. A person becomes virtuous by living and practicing the virtues in her daily, lived experience, by developing the skills necessary to discern the appropriate time for the appropriate virtue in a given situation.

In thinking about virtue as encompassing both the decision-making process and the ensuing action, Aristotle summarizes the former as "[having these feelings] at the right times, about the right things, towards the right people, for the right end, and in the right way, is the intermediate and best condition, and this is proper to virtue" (1106b21-24).[10] A person's motivations are important in virtue ethics because they reveal a person's character over time. Motivations reveal an integrity, a wholeness or consistency of one's character, that the moral agent's kind action is reflective of her character, and that the kind action is done out of kindness and care, not out of what might be gained by the moral agent. If virtue is supposed to become part of a person's character, then the person's motivations help illustrate how close those virtues are to constituting that person's identity. Presumably, appropriate motivations indicate a person's identification with the virtues,

[10] Ibid., 44.

while inappropriate motivations indicate the person has not quite incorporated virtues into her center of being. Because the scientist is motivated by her *telos*, which includes doing science well, she habitually exercises patience, ingraining patience into her character, because she knows she needs it for scientifically sound results. In this example, the virtuous scientist is not patient for other reasons, such as using patience to show her colleagues what a hard worker she is. The agent's motivations indicate her character and knowing the agent's character is central to virtue ethics.

When discussing virtue, Aristotle characterizes the virtues as a mean between two extremes. At one end is a vice of deficiency, while at the other is a vice of excess and balanced between the two is the virtue. In what has come to be called the Golden Mean, Aristotle defines virtues as an intermediate as "a state that decides, [consisting] in a mean, the mean relative to us. . . . It is a mean between two vices, one of excess and one of deficiency" (1107a1-4).[11] For example, one of Aristotle's main virtues is courage. He argues the vice of deficiency for courage is cowardice, while the vice of excess is recklessness. The virtue of courage lies between the vices of cowardice and recklessness, with the moral agent able to discern when the situation is appropriate for him to exercise his courage and stand firm. In Aristotle's conception of virtue, virtues are outnumbered two to one; there are two vices for every virtue. However, the Golden Mean has become increasingly criticized in recent times. Critics argue that not all virtues lie neatly between two opposing vices. Some virtues may only have one vice. For example, the virtue of justice can be understood as having only one vice, injustice. To Aristotle, the virtue of justice entails

[11] Ibid.

discerning what is appropriately due to others, as well as ensuring one's own due share. While someone can certainly have more or less than her due share, both of these are indicative of injustice, which can be thought of as a deficiency of justice. However, the Golden Mean does point to an important nuance of virtue ethics, that virtue is a difficult path with many temptations that can cause one to become derailed. Despite the problems of this view, it points to Aristotle's understanding of the difficulty of pursuing virtue. His attempt to structure a relationship between the virtues and the vices can be seen as a way of making virtue ethics as something able to be navigated and laying down a guide for those who choose to pursue it. While a particular virtue might not always be flanked between two opposing vices, it can still be understood as a way of being that requires constant and careful hard work.

While Aristotle believes that all people should work on cultivating all the virtues, he also emphasizes that the virtues are also dependent upon the person and can vary between situations. A virtuous act for one person may not be virtuous for another; the mean is relative to each person's capabilities and resources. Virtue is not a universal, external standard that each person should work towards, but is determined according to each person's role and situation and will vary between people. Each person must develop her own ways of deciding and evaluating virtue. Variation in the virtues between individuals is related to the roles they hold. To understand the range of virtue that results from the differences between people, one can look at how various professions require different proportions of the virtues for those working in that field than those outside of it. A firefighter or a soldier needs more courage than the average person, and a judge needs a well-developed sense of justice. These virtues are critical to the nature of their jobs, and those working within them are expected to embody these virtues more than others.

However, even though these professions may require more of these virtues for those working within them than for those who do not, this does not mean those within various professions can eschew the other virtues. There may be times when a firefighter needs justice or compassion. Or times when a judge needs courage. There is no finite amount of total virtue one person can hold in herself, so developing one virtue should not come at the expense of another virtue. Exhibiting a particular virtue more frequently through one's profession should not prevent the development of the other virtues. One feature of the virtues is their irreducibility, where at least cultivation of a few key virtues are necessary for a life well lived, and one deeply cultivated virtue does not compensate for deficiencies in another virtue.

Additionally, Aristotle discusses the role of developing *phronêsis*, often translated as practical wisdom. Aristotle separates the virtues into moral virtues and intellectual virtues. Moral virtues are those such as courage, temperance, and patience. These are not innate, but must be developed through habitual practice and are typically action oriented. In contrast to the moral virtues are the intellectual virtues, and this category of virtue "arises and grows mostly from teaching, and hence needs experience and time" (1103a15-16).[12] The intellectual virtues are virtues of thought and often help guide the moral virtues. Within the intellectual virtues, Aristotle places *technê, sophia, nous,* and *epistêmê,* along

[12] Ibid., 33.

with *phronêsis*, but I will focus only on *phronêsis* because of the role it plays in enabling the scientist explore her work's social and moral contexts.

For the intellectual virtues Aristotle creates two distinct categories, classifying the intellectual virtues by the kind of knowledge they represent. He divides the intellectual virtues into the scientific part of the soul or the rationally calculating part of the soul, where "[w]ith the calculating part we consider (*theôroumen*) things which admit of change whereas with the scientific part we consider things which do not admit change. Things which admit of change are, e.g., the contingencies of everyday life; things which do not admit of change are, e.g., the necessary truths of mathematics."[13] With these categories created to address different ways of thinking and types of knowledge, *phronêsis* is placed with the rationally calculating part, the part concerned with practical thinking (*prakitikê dianoia*) whose truth or falsity is determined with respect to appropriate desires and action. It relies upon a situation's contingencies and nuances, the moral agent's correct desire, and appropriate action. Aristotle defines *phronêsis* as "a state grasping the truth, involving reason, concerned with action about what is good or bad for a human being" (1140b5-6).[14]

Phronêsis is conceived as the virtue necessary for enabling correct decisions and actions when confronted with many options; it is the ability to deliberate well. Unlike the universalism of factual knowledge (such as, a rectangle always has four right angles), this type of knowledge depends upon the contingencies of a situation and the past experiences

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[13] Richard Parry, "Ancient Ethical Theory," *Stanford Encyclopedia of Philosophy*, last modified October 28, 2007, accessed August 8, 2012, http://plato.stanford.edu/entries/episteme-techne.

[14] Aristotle, *Nicomachean Ethics*, 154.

of the moral agent. *Phronêsis* guides the moral agent through difficult choices and actions, helping her find a virtuous path. Explaining more about this, Martha Nussbaum writes:

> The person of practical wisdom is a person of good character, that is to say, a person who has internalized through early training certain ethical values and a certain conception of the good human life as the more or less harmonious pursuit of these. He or she will be concerned about friendship, justice, courage, moderation, generosity; his desires will be formed in accordance with these concerns; and he will derive from this internalized conception of value many ongoing guidelines for action, pointers as to what to look for in a particular situation.[15]

Phronêsis is a way of thinking through situations that allows the proper expression of the virtues. Similar to an archer aiming an arrow, the moral agent has in virtue an end to aim for, and *phronêsis* gives her the means to realize it. Explaining further, Norman O. Dahl writes, "practical wisdom involves more than the ability to deliberate well about means. . . practical wisdom gives a person a grasp of those ends that are part of virtue."[16] *Phronêsis* not only cultivates deliberating well, but also helps the moral agent more clearly see the virtuous ends.

Practical wisdom enables the individual to pursue her internalized vision of the good by developing her ability to evaluate situations and make decisions which will put the individual closer to her *telos.* Because each person's pursuit of the virtues depends upon her particular situation and because moral reasoning is not universal in the same sense as mathematical reasoning, part of deliberating well entails paying close attention to a situation's contingencies when deliberating what virtuous behavior would require.

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[15] Martha C. Nussbaum, *The Fragility of Goodness: Luck and Ethics in Greek Tragedy and Philosophy* (Cambridge, UK: Cambridge University Press, 1986), 306.

[16] Norman O. Dahl, *Practical Reason, Aristotle, and Weakness of the Will* (Minneapolis, MN: University of Minnesota Press, 1984), 65.

Phronêsis allows the moral agent to discern the situation's pertinent details, based upon her past experiences. The role of experience is crucial to developing *phronêsis*, because, while deliberating well can be taught and modeled to an extent, one must learn how to deliberate well by endeavoring to do it herself. Learning how to discern through the details will allow the moral agent to appropriately respond to a situation. For the scientist then, *phronêsis* enables her to discern when patience is needed when working through her experiments. She uses it when deciding to stay with her planned protocol and work through its complexities. But she also uses *phronêsis* when deciding to change her protocol, not out of impatience or flightiness but because she comes to realize the planned path will not yield sound data. Regardless of what she chooses, it is at this juncture that the scientist employs *phronêsis* in making her decision.

Although it is typically categorized as an intellectual virtue, *phronêsis* bears characteristics of the moral virtues, particularly in its development. Like the moral virtues, practical wisdom must be cultivated over a lifetime, through habit. In some ways, it acts as a bridge between the moral virtues and the intellectual virtues. While *phronêsis* must be cultivated through habituation, it is not an act in and of itself like the moral virtues of courage or patience. Instead, it helps the moral agent discern which moral virtues to employ and how to use them. Through repeated effort, *phronêsis* will become internalized, part of a person's character and "[t]his continuous basis, internalized and embodied in the agent's system of desires, goes a long way towards explaining what that person can and will see in the new situation: an occasion for courage, for generous giving, for justice."[17]

[17] Nussbaum, *The Fragility of Goodness*, 306.

Cultivation of *phronêsis* enables the moral agent to discern if a situation requires courage, generosity, or temperance, or some combination of the virtues. And through habitual cultivation, *phronêsis* becomes ingrained into the fabric of a person's being. Through trying many experimental protocols, some successful and some failed, *phronêsis* enables the scientist to more easily discern if patience is needed for future situations. *Phronêsis* is needed for many facets of science, such as discerning through its scientific complexities, as well as its moral ones. The role *phronêsis* can play in helping the scientist discern science's moral features will be more extensively discussed in the next chapter.

Of course virtue ethics is not the only framework available when working through science's moral features, as briefly mentioned earlier. In contrast to virtue ethics, other philosophical approaches, such as utilitarianism and principlism, focus less upon the moral agent's character and use different rubrics for analyzing a situation. With principlism, the moral agent is guided by universal principles, such as respecting autonomy or promoting beneficence. These principles were formed in the abstract, with the expectation of guiding the moral agent towards decisions that adhered to these principles in a wide variety of situations. Utilitarianism argues that a correct action is one that maximizes the benefits and minimizes the negative consequences for the greatest number of people. Both principlism and utilitarianism use already formulated rules for producing correct actions within their frameworks. To an extent, principlism and utilitarianism are reductionist by expecting general rules to comprehensively and satisfactorily attend to the moral features in a wide variety of situations. The situations' context and the moral agent's values and perspectives are not included, or are minimal, when deciding upon action. In contrast, virtue ethics grapples directly with questions about the moral agent's values and the situation's context in decision making. The character and development of the moral agent are crucial to virtue ethics because virtue ethics argues virtuous behavior stems from virtuous character.

While virtue ethics does not suffice as a comprehensive ethical framework, it centrally places features of the situation that principlism and utilitarianism tend to overlook. Both principlism and utilitarianism to an extent presuppose the moral agent possesses something like *phronêsis* in deciding which principle to apply or what action will maximize benefits, but neither explicitly discusses this component. By focusing upon the outcomes of the moral agent's decisions, the features that are part of the decision-making process, such as the moral agent's motivations, character, and reasoning used, are lost. In contrast, with virtue ethics, the moral agent's character and the decision-making process she uses is brought to the forefront. The various facets of the decision-making process are important, with particular attention paid to the way the moral agent reaches her decision. However none of the ethical systems mentioned, including virtue ethics, can satisfactorily address all the moral issues in a complex situation. Instead, virtue ethics, along with principlism and utilitarianism and other frameworks not discussed, should be used alongside each other to supplement their respective shortcomings. Because of their perspectives and the features they emphasize, the various frameworks can only illuminate some of the moral landscape. Virtue ethics highlights the role in the moral agent's character and decision-making process that principlism and utilitarianism generally overlook. But principlism and utilitarianism provide the moral agent with a set of generally straightforward and concrete rules to apply, which can serve as useful guides when navigating a situation. And while virtue ethics does provide action oriented guides—do the acts that promote virtue—they are not as direct and explicit as other frameworks, which can cause considerable difficulties for the moral agent, particularly the novice.

Aristotle's account of virtue ethics examines the agent's character, as developed over many years. Placing emphasis on virtue as cultivated over a lifetime of habitual exercise gives an intelligibility to the moral agent's actions that is often overlooked by other moral frameworks. In contrast to virtue ethics, many contemporary moral theories emphasize the eventual action produced by appropriate reasoning within their frameworks, while neglecting the circumstances of the situation and the moral agent's character. However, virtue ethics brings these features into focus by making them critical components of the moral landscape. Virtue ethics focuses upon the character of the moral agent, trying to make sense of her actions by looking at the whole of her life. Aristotle's characterization of the virtues as necessary for a life well-lived can be used as a framework that enables us to think about science as an enterprise that relies upon the cultivation of virtues if it is to be practiced morally. While Aristotle developed the basic structure for virtue ethics that continues to this day, Alasdair MacIntyre reworks it somewhat, placing the *telos*, virtue, and its cultivation within a specific definition of a practice. He discusses how through practices virtue is cultivated by those within the practice and the *telos* of the practice is achieved. For understanding science as a practice and what is needed for scientists to reach its *telos,* I now turn to MacIntyre's discussion of virtue ethics.

MacIntyre and Virtues within a Practice

In his book *After Virtue*, Alasdair MacIntyre reworks Aristotle's construction of virtue ethics. MacIntyre has written on wide range of topics, such as "theology, Marxism, rationality, metaphysics, ethics, and the history of philosophy" and draws upon virtue ethics as a guide for building political communities that enable individuals to cultivate the virtues that enable them to fulfill their *telos*.[18] Although he leaves aside some features of Aristotle's virtue ethics, such as questions about the Golden Mean, like Aristotle, MacIntyre also constructs his conception of the virtues as necessary for achieving goods. However, he expands upon Aristotle's conception of the goods by placing them within practices, which he defines as "any coherent and complex form of socially established human activity through which goods internal to that form are realized in the course of trying to achieve those standards of excellence which are appropriate to, and partially definitive of, that form of activity, with the result that human powers to achieve excellence, and human conceptions of the ends and goods involved, are systematically extended."[19]

According to this definition, practices have several crucial features, each of which I will discuss in detail in this section. However, I will first give a brief overview of the various components. A practice, then, encompasses the following components: 1) is a sufficiently *coherent* and *complex* human activity, 2) has internal goods that are only achievable through doing the practice, 3) has standards of excellence that its practitioners strive to achieve through careful and persistent diligence, 4) is defined, at least in part, by

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[18] Ted Clayton, "Political Philosophy of Alasdair MacIntyre," *Internet Encyclopedia of Philosophy*, last modified December 31, 2005, accessed November 7, 2012, http://www.iep.utm.edu/p-macint/.

[19] MacIntyre, *After Virtue*, 187.

its standards of excellence, 5) is continually redefined, reshaped, and extended by its practitioners trying to achieve its standards of excellence, ends, and goods. For something to be considered a practice, it must be a human activity that is sufficiently complex, constructed through the visible actions of the practitioners and through the less evident, less tangible work of the practitioners. Thus a practice usually encompasses many seemingly simple actions, but is much more than the visible actions of the practitioners. A practice also has goods, such as the internal goods mentioned in the definition and also external goods. The internal goods are achievable only by doing that one particular practice, while the same external goods are achievable through a variety of practices. This distinction between internal and external goods is important because the internal goods partially define the practice; they help distinguish one practice from another. These internal goods are achievable by pursuing the standards of excellence particular to that practice. Thus each practice has "gold standards" that its practitioners should strive towards. For those new to the practice, their abilities will initially fall far short of the standards of excellence, but they can become more skillful in the practice through careful and persistent pursuit of those standards. Gradually, as their abilities accumulate and as they begin to achieve those standards of excellence, the former newcomers develop into skilled practitioners. Through pursuit of the internal goods, skilled practitioners may change the practice's standards of excellence or its internal goods. Thus the boundaries and definitions of the practice are not static, but ever changing through those working within the practice. MacIntyre places the development and exercise of virtues within practices where the virtues are necessary for meeting a variety of goods specific to that practice.

Not everybody can join whichever practice they desire, but must be accepted by current members of the practice. One enters as a novice, agreeing to learn the skills, knowledge, and standards of excellence needed to become a practitioner, which current practitioners already embody. Membership into a practice can be exclusive, admitting new members through either a formal or informal selection process. Once accepted, the novice often goes through an apprenticeship period, during which she learns the necessary knowledge and skills, while also coming to identify with the practice's values and assumptions. For the novice to become an accepted member, she has to accept and adhere to the norms and values of the practice and strive towards achieving its standards of excellence. Joining a practice and becoming recognized as a skilled and contributing member of the practice takes both acceptance by others within the practice and continual accumulation of the practice's methods and values. Accepted members of a practice also typically have access to the knowledge and privileges specific that practice, which can be closed to those outside of it. The standards of excellence are usually expressly taught and modeled by the more experienced members to the novices. She begins as a novice and gradually becomes more proficient and experienced in the practice, leaving the apprenticeship phase (sometimes marked by a formal ceremony), and eventually comes to mentor other novices to the practice, thus repeating and sustaining the practice.

Thus science is a type of practice, while making buffer solutions is not. Learning to make buffer solutions is relatively simple; it takes some time and instruction but can be mastered after some effort. In contrast, developing into a scientist is much more difficult and complex than merely learning to make buffers solutions. The scientist must first sufficiently demonstrate her interest in science and potential to flourish in science and apply to a graduate program. Then she must be formally selected amongst many applicants for admittance into a graduate program, at an institution where the scientific community has already given its tacit approval that the institution is qualified to train scientists, usually through an accreditation process. This gives her the scientific community's permission and support to join the scientific practice. Then she must go through a training period, which in the biosciences includes technical skills such as making buffers. But this apprenticeship period also familiarizes her with and teaches her how to uphold the standards and goals of science, such as how to craft her experiments, how to interpret her data, how to continually reexamine her experiments, her data, and her interpretations of that data, and how to communicate her work to the larger scientific community and general public. In part, the expectation of this training period is for the learner to assume the identity of the scientist. Part of the molding that takes place during this apprenticeship is for the learner to shed her lay person status and become an accepted member of the scientific community by changing her identity to include the values of science. She comes to support science's desire for objective knowledge, its attempt to quantify the natural world, and its continued search for new avenues of inquiry. She begins to incorporate these values into her own identity, aligning her character with the values of scientific practice. Entering a practice changes the identity of the novice, and part of that change entails coming to identify with and carry out the practice's norms and values, in ways the lay person cannot.

At some point, the apprenticeship period ends, and the novice is no longer a novice but a new scientist, upholding and perpetuating science's values. Although this identification with science's values varies between individuals, the transition to new scientist is often marked by a graduation ceremony. Eventually, the new scientist becomes a mentor to other novices working to become scientists, teaching them science's standards of excellence and guiding them through their own transition from lay person into scientist. As accepted members of science, scientists are given special access to scientific knowledge through their specialized training and access to the scientific community through journals and conferences. While making buffer solutions well is an important component of scientific practice and can help realize some of science's goods, it is not a complex, multifaceted human activity that has standards of excellence only scientists can achieve.

The definitions and boundaries of the practice are shaped by those within it, who further extend and alter its standards of excellence. The goods of practices are not permanently fixed, but "are transformed and enriched by these extensions of human powers and by that regard for its own internal goods which are partially definitive of each particular practice or type of practice."[20] As the skills and techniques of those within the practice change, so does the definition and the boundaries of the practice itself. The methods of achieving its standards of excellence change over time as well. Science as it is practiced today is very different from how it was practiced several hundred years ago, in part because of its continuously expanding boundaries. Some of these shifting boundaries have stemmed from changes in our conceptions of our place in the universe, thinking of natural phenomena as regulated by consistent laws that are knowable to us, and developments in technologies and techniques. Humans are no longer thought of as the

[20] Ibid., 93.

most perfect and ideal being, a product of divine creation, but as one among many other creatures that developed over millennia. The workings of the natural world, including how they occur in humans, are no longer thought to be divinely ordained, thus exceeding our capacity to understand, but instead as all subject to the same mechanisms and laws that are within our capacity to comprehend. This shift has happened gradually over the past several hundred years, in different parts of the sciences at different times. It has been accompanied by changes in the types of knowledge the scientific community accepts and methods of obtaining that knowledge.

These changes have come from those within the scientific practice as they defined science's boundaries and scope. Those engaged in the practice are the ones most qualified to establish these standards of excellence and to recognize when someone achieves them because of their experience in and familiarity with the practice. Practicing scientists were the ones who challenged what could and could not be discerned about the natural world. Through debates about new technologies and techniques, about acceptable forms of knowledge, about appropriate forms of reasoning, they argued over where science's boundaries lay, what limitations science had, and what it was to excel in science. And although nonscientists may have had opinions on these matters, it is the scientists, debating amongst themselves, who perpetuated the cycle of settling the questions and then challenging them. To those new to a practice, entering a practice is to submit to the authority of those already in the practice. However, at a later stage in development, the excellent practitioner becomes an authority who continues the practice's tradition. Once the practitioner is intimately familiar with the practice's values and assumptions, as well as its contentious areas, she can decide to take the practice in a radically different direction, overturning the previous tradition. Thomas Kuhn discusses these radical changes in traditions as paradigm shifts, which happen when the entrenched way of practicing is no longer adequate to address the pressing questions that confront it. He points out that many of the radical changes in practices have come from its younger members, as they are knowledgeable about the practice's goals, values, and standards of excellence, but not so attached to a particular way of seeing the practice and doing things.[21] However, before the scientist can do this, she must first develop into a skilled practitioner who is familiar with its present standards of excellence.

Practices are comprised of goods, both internal and external. Although some goods of a practice are not easily classified as internal or external, for simplicity I will treat internal and external goods as possessing distinct boundaries from each other. The goods external to a practice are not exclusive to one practice but achievable through a variety of practices. Wealth and fame are goods external to practices because they are goods that can be achieved through many practices, but they are not defining characteristics of any practice. Scientists can become wealthy and famous through their scientific work, but so can lots of practitioners of other practices, such as physicians, athletes, and politicians. External goods are also usually objects of competition, that is, while most practitioners would like to be wealthy and famous, not all can be. While most scientists, athletes, politicians, or physicians will be wealthier than the average person, a select few will be wealthier and more publically admired than their peers.

[21] Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 3rd ed. (Chicago, IL: University of Chicago Press, 1996), 90.

In contrast to the external goods, the internal goods are achievable only by doing the practice and are partially definitive of the practice. The practice's standards of excellence both help determine and reflect its internal goods. For scientists, producing reliable knowledge about the natural world is an internal good that all practitioners of science strive towards and is only accomplished by participating in the practice of science. Science is defined by its ability to authoritatively yield accurate and replicable knowledge about the natural world, and the excellent practitioner of science constantly works towards doing this task as well as she can. Thus for a scientist to strive towards science's internal goods, she must craft her experiments and interpret her data to the best of her ability, in ways that are most likely to yield accurate knowledge about the natural world. For crafting an experiment well, the scientist must consider the experiment's limitations and biases and acknowledge them when interpreting her data and discussing the results with others. For interpreting data, the scientist must try to put it together in a way that is the most reasonable, given the present state of her field and regardless of how it may contradict her expectations or hopes. Other internal goods might include the mentoring and training of new scientists or critically evaluating new scientific knowledge according to currently accepted standards.[22]

[22] I want to note that while I focus more on the internal goods than the external ones, I do not mean to be dismissive of the external goods. And although the external goods are not the reasons the virtuous practitioner does the practice, they are still critical to the sustainment and continuation of the practice. For example, accumulating a certain amount of wealth is necessary because it enables the practitioner to focus on the achieving the practice's internal goods. Indeed many practices are sustained by the institutions that house them, where a main focus of these institutions is achieving the external goods necessary for the practice's continued existence. Similarly, the useful technologies developed form scientific knowledge are external goods (as science can produce reliable knowledge about the natural world without yielding any useful technologies), which are highly prized and often contribute to the furthering of science's internal goods in a particular area, through increasing financial and social support.

A vision of science's internal goods and standards of excellence enables the scientist to work towards science's *telos*. Expanding upon Aristotle's conception of the *telos*, MacIntyre describes the *telos* as providing "a conception of *the* good which will enable us to order other goods, for a conception of *the* good which will enable us to extend our understanding of the purpose and content of the virtues. . ."[23] As individuals have conceptions of a life well-lived, practices also have ways of being practiced well, that are reflected in their internal goods and standards of excellence. And as with individuals, the *telos* provides the practice with the necessary framework that puts the practitioner on the path to cultivating the appropriate virtues for that *telos*. What, then, is science's *telos*? What does a science practiced well entail? Although pinning down a universally true *telos* for individuals is impossible because of the wide variety of goals and values, for practices, the field is a bit narrower because a practice's internal goods and standards of excellence help define its *telos.* One can have a life well-lived (or not) as CEO of a major company or as some who stays at home all day, depending on how her vision of the *telos*. But to be a scientist, one must produce knowledge that helps explain natural phenomena. To do otherwise is not science.

At first glance, science's *telos* encompasses producing reliable and reproducible knowledge that explains phenomena about the natural world, and this is certainly a critical and defining feature of science. Without it, there is no science. However, this definition does not sufficiently address some of science's other important features, specifically its moral and social dimensions. Perhaps science's *telos* can be expanded to include those

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[23] MacIntyre, *After Virtue*, 219.

features. As discussed in the previous chapter, science is an enterprise with significant social and moral dimensions, which have considerable consequences for the world it inhabits. Because science does not operate in a vacuum and because of the special obligations it engenders from its privileged place, scientists have responsibilities to attend to and reflect upon science's moral and social features and how they relate to their work specifically and scientific practice in general.   With this, practicing science well then encompasses understanding and reflecting upon its wider context. Understanding science's relationship with the nonscientific spheres of society generally has not been part of science's general development. However, by reshaping science's *telos* in a way that includes attending to its context, this reflection can become a part of science's tradition, becoming woven into the fabric of scientific practice. As a practice's boundaries, *telos,* and ways of achieving that *telos* necessarily shift as its practitioners develop new technologies, methods, and frameworks, a *telos* that focuses strictly on the production of scientific knowledge, irrespective of its larger context, is no longer tenable. Science and society exert significant influence upon each other and scientists' consideration of those features is important for the future directions of both science and society.

As with Aristotelian virtue ethics, realizing a practice's *telos* and internal goods requires the scientist to cultivate the necessary virtues. And often, acting virtuously is in opposition to what seems easiest in the present moment (such as sloppy record keeping, drawing conclusions from a cursory examination of the data, or failing to attend to an experiment's biases and limitations) requiring the practitioner to deliberately choose a virtuous path. The goods internal to the practice constitute its ends and are only achieved through striving for excellence in the practice, through cultivation of virtue. Concerning the virtues' place in achieving a practice's internal goods, MacIntyre writes, "A virtue is an acquired human quality the possession and exercise of which tends to enable us to achieve those goods which are internal to practices and the lack of which effectively prevents us from achieving any such goods."[24] A clearer picture of a practice is forming; a practice is a complex human activity with individuals working within its boundaries in pursuit of its common goals. A practice functions as an established and protected spaces for the cultivation and expression of the virtues necessary for doing and furthering the practice, often through a particular role that is defined through the practice. Thus the virtues in MacIntyre's practices function in the same way as they do for Aristotle's virtue ethics. They enable the practitioner to realize her desired ends, to achieve a practice's internal goods, standards of excellence, and overall *telos*; without possession and development of virtue, attaining these is impossible. For excellence in the practice, the practitioner must cultivate the virtues important to the practice in order to meet the practice's internal goods. For science, in order to speak authoritatively about the natural world, the practitioner would need to excel in scientific knowledge and technical proficiency. To become scientifically knowledgeable and technically proficient, the virtuous scientist would need to cultivate patience, courage, and honesty, among other virtues, as previously discussed. Additionally, the internal goods are the reason why the virtuous practitioner participates in the practice and derives satisfaction from doing the practice well.

[24] Ibid., 190.

However, in addition to allowing the practitioner to pursue internal goods, the virtues also contextualize the practice, placing it within its traditions and historical development. The virtues function "not only in sustaining those relationships necessary if the variety of goods internal to the practices are to be achieved and not only in sustaining the form of an individual life in which that individual may seek out his or her good as the good of his whole life, but also in sustaining those traditions which provide both practices and individuals with their necessary historical context."[25] Virtues allow both individuals and practices to realize their ultimate good, while also connecting them with the histories and traditions that extend beyond any singular individual or practice. When entering a practice, the individual enters a tradition that stretches beyond the current state of the practice. Exercise of the virtues allows the individual to realize the goods internal to the practice, while also creating a way for the individual to contribute to the continuation of the practice and its traditions. Scientists need the virtues in order to realize science's internal good, the production of factual scientific knowledge. But virtue also brings them into dialogue with scientists past, as well as those present, and they become the bearers of the science's traditions.

The connection between practice and tradition is a key feature of MacIntyre's conception of the virtues that is not present in Aristotle's discussion of virtue. However, to understand the relationship between practice and tradition, we must first further explore why MacIntyre sees traditions as crucial to cultivating virtue. MacIntyre explains, "[T]he unity of a virtue in someone's life is intelligible only as a characteristic of a unitary life, a

[25] Ibid., 223.

life that can be conceived and evaluated as a whole" and even the individual's concept of herself "resides in the unity of a narrative which links birth to life to death as narrative beginning to middle to end."[26] The virtues cannot be understood when separated from the context of the moral agent's life, while the moral agent cannot be understood when separated from the narrative of her life. For the moral agent's virtues to be comprehensible, her life as a unified whole must first be understood. A person's actions become intelligible when understood contextually; the intentions, motives, passions, and purposes that undergird her actions are brought in to explain the reasons for action.

Analogous to how an individual is in part defined and made intelligible by the traditions and contexts that inform her life, practices are similarly constituted. Like individuals, practices have their own traditions and histories that in part define their identity and their ends. MacIntyre argues, "the history of a practice in our time is generally and characteristically embedded in and made intelligible in terms of the larger and longer history of the tradition through which the practice in its present form was conveyed to us."[27] Like individuals, practices have living traditions; they are socially and historically embedded and draw their identities from their contexts. Both individuals and practices become comprehensible when one look's at their histories and contexts. The practice's tradition helps inform and sustain the pursuit of the same (or similar) goods through the generations, maintaining these goods despite the constant change in people who practice it. Contextualizing the practice makes its *telos* comprehensible to the current generation of practitioners, showing how and why some goods, values, or methods have changed over

[26] Ibid., 205.
[27] Ibid., 222.

time, while others remained the same. For science, its tradition is long and multifaceted, with science practiced in a variety of ways in different places and times. Despite the disagreements about what constitutes excellent scientific work, the overarching good of science has been for the past several hundred years, and still remains, to understand natural phenomena through universal laws and mechanisms.

Science's traditions and histories not only provide continuity to its goods, but also show why and how science has changed over time, why scientists gradually rejected explanations of the natural world that relied upon divine intervention, and why scientific knowledge is among the most authoritative forms of knowledge today. However, when viewed within its social, historical, and moral contexts, science is more than producing knowledge that explains natural phenomena. Certainly science's history explains why that has become science's overarching good, but any history of science is incomplete when the social factors that shape science and the ways science has changed society are not explored. It is possible to understand the scientific features of the germ theory of disease without mentioning what led to it or what precipitated from it. However, it only really becomes intelligible as to why it was so contentious, so important, and its general place in the development of science when discussed in light of how it changed theories of disease causation and its contributions to advances in vaccine development. The practice of science has always had its moral and social contexts that stretch beyond the generating of scientific knowledge but are often left unexamined by its practitioners. However, those features are as much a part of science's histories and traditions as what counts as legitimate scientific knowledge and which areas of science are expanding and branching and why, and should be examined by scientists as part of doing good science. A more complete picture of science's traditions, history, and contexts is formed when incorporating discussions of science's relationship with society alongside discussions of producing legitimate scientific knowledge and is necessary when creating a responsible and ethical practice of science. Practices become intelligible through their contexts, histories, and traditions, and since practitioners are the ones that primarily shape and perpetuate a practice, they have obligations to do their practice in a way that deliberately attends to those features.

As a practice's tradition and history give intelligibility to its current state and future directions, cultivation of the virtues enables the practitioner to sustain and continue her practice, where she in turn continues and shapes its tradition for future practitioners. Through the practice's past and the way it is presently practiced, current practitioners leave a legacy for future practitioners. This focus on a practice's tradition and history emphasizes the need to contextualize the practice so that it becomes comprehensible when understood as part of its larger context. For science, then, virtue includes not only pursuing its *telos* of producing reliable knowledge about the natural world but also understanding why this is science's *telos* and questioning if that sufficiently captures science's *telos.* One of the goals of this chapter and the larger work is to argue that science and society share significant relationships, engendering responsibilities on the part of the scientist to contextualize her work. From a virtue ethics perspective, this responsibility becomes a part of science's *telos*.

Placing science within a virtue ethics perspective highlights some of science's moral features, specifically the role of the scientist and her character in directing the future of science and society. By holding a conception of her *telos*, the scientist can cultivate the virtues needed to practice science well and lead a life well-lived. Virtue ethics helps illuminate some of science's moral features by locating appropriate actions as stemming from the moral agent. She must cultivate virtues that enable her to have the appropriate desires, motivations, and intentions, which then result in appropriate action. Virtue ethics draws attention to the moral agent's character and the decision-making process. And as individuals have conceptions of a life well-lived and virtues that must be developed to realize that end, practices also have a *telos*, ways of being practiced well, and necessary virtues their practitioners must cultivate to meet the goods of the practice.

Looking at science's many moral and social features from a virtue ethics perspective can provide a starting point for the scientist grappling with these features. From a virtue ethics framework, cultivation of the virtues is necessary for the scientist to realize this proposed shift in science's *telos*. She needs a set of approaches and habits, ingrained upon her character, that enable her to contextualize her work, and scientific practice in general, to help her develop a science that strives to be responsible and ethical, as well as scientifically accurate. However, a different set of virtues, distinct from what the scientist already needs for her scientific work, should not be necessary, but instead perhaps applied in a different way. To contextualize her work, the scientist will still need the virtues of patience, courage, and honesty, among others. But in addition to bringing these virtues to her task of generating knowledge, she also needs to exercise them when examining science's moral landscape. My purpose is not to compile an exhaustive list of what virtues are needed for practicing science well, but rather to focus on a virtue that is critical to achieving science's *telos*. *Phronêsis*, the intellectual virtue that enables the cultivation and appropriate exercise of the moral virtues, is necessary for the scientist to practice science well, both to produce scientific knowledge, such as planning sound experiments and appropriately interpreting her data, and to create a science that is attentive to its moral and social dimensions, such as understanding how social norms and values have shaped a particular research question and taking steps to ensure her biases and assumptions do not result in unfair treatment of people. Although in this chapter I outlined *phronêsis* and how it functions within virtue ethics, the next chapter will further discuss and expand upon *phronêsis*, what it entails, and how its cultivation can help the scientist contextualize her work.

Chapter 3- *Phronêsis*, Reflective Practice, and Moral Imagination

In grappling with science's moral features, virtue ethics places the character of the scientist in the center of its framework. It focuses on cultivation of character as necessary for making decisions and actions that are appropriate for a particular situation. For a virtuous life, the scientist must cultivate and exercise the virtues necessary for her pursuit of a life well-lived. For actions to be virtuous, they must be reflective of the scientist's character. The virtues must become part of who the scientist is, where virtuous actions are only virtuous when they are deliberately chosen, backed by the appropriate motivations and intentions. And similar to how virtues and the *telos* help an individual define and pursue a life well-lived, virtues and the *telos* also partially constitute the practice and create a picture of what it is to do the practice well. Virtues in a practice also sustain and continue the practice, with current practitioners passing on the virtues to future practitioners. For science, the virtues enable the scientist to practice science well. While practicing science well has typically been defined as producing reliable and reproducible knowledge about natural phenomena, this definition of science's *telos* ignores its moral dimensions and the space it occupies within society. However, practices in their present state do not spring full-formed into existence, but are slowly shaped and reshaped over time. Through understanding a practice's history and traditions, its present state becomes intelligible. If practices are made intelligible, and also shaped, by their pasts and contexts, and practitioners are the primary shapers of a practice, then its practitioners should pay attention to the practice's past and contexts in order to deliberately craft a practice that makes sense of and attends to its contextual features. For scientists, this means reflecting upon science's relationship with society and its moral dimensions, in addition to producing reliable scientific knowledge, for practicing science well.

To practice science well, by this definition, the scientist needs to exercise the virtues she likely has already developed for generating scientific knowledge well. I highlighted one virtue in particular, *phronêsis*, roughly translated as practical wisdom, and is critical in enabling the cultivation of the other virtues.[1] This virtue enables the moral agent to decide upon correct decisions and appropriate actions; it is the ability to deliberate well. Indeed cultivation of *phronêsis* is critical to the production of reliable scientific knowledge. Generating scientific knowledge is difficult and complex, requiring a fine attunement to many factors the scientist must consider, such as understanding where her experiment sits in the exiting body of knowledge, choosing which technique or technology is most appropriate, knowing how to appropriately interpret her data, and troubleshooting problems as they arise in the generation and interpretation of her data. However, *phronêsis* is also necessary for when grappling with science's moral dimensions for those features of science can be fraught and difficult to parse. *Phronêsis* helps the moral agent discover a virtuous path through these difficulties and decide which virtue is appropriate for the situation. To discern this path, she draws upon past experiences and pays attention to the specific contours of the situation, winnowing through its many features to pick out the pertinent ones. Like the moral virtues, *phronêsis* is cultivated over a lifetime of careful

[1] My focus on *phronêsis* is not to suggest other virtues are unnecessary or unimportant. However, I choose to exclusively discuss *phronêsis* because of its potential role in helping scientists contextualize their science.

work. While *phronêsis* is important in all areas of life, I will focus mainly on its cultivation for the virtuous scientist.

From the perspective that scientists have obligations to attend to their work's larger contexts, good scientific work extends beyond producing reliable, replicable data, but also encompasses the moral and social considerations of its consequences. The virtuous scientist sees these features not as external to science, but as inextricably connected with science, and legitimately within the scope of what scientist ought to consider. *Phronêsis* helps the scientist contextualize her work, and enables her to discern a path that takes the seemingly disparate moral and social features into account. With *phronêsis,* this type of deliberation is not only done retroactively, but as part of the planning process when determining future directions for a line of scientific inquiry. Although no one can be completely certain of science's future implications, taking an expansive view of what scientists should consider in planning and conducting their research could help develop a responsible and virtuous scientific practice that builds moral and social considerations into its framework.

To illustrate how *phronêsis* can function in an expanded understanding of science, consider the scientist who is working on developing treatment for sickle cell anemia, a disease whose history demonstrates how intertwined scientific questions are with social concerns. Those with sickle cell anemia suffer episodes marked by pain in the bones, abdominal pain, breathlessness and fatigue, and a host of other symptoms that can last from hours to days. The symptoms' frequency ranges between several times a year to every few years, whose severity ranges between mild and brief for some patients to prolonged and extremely painful for others. Even when not suffering from painful episodes, patients require ongoing treatment and paying close attention to what may trigger an episode. Sickle cell anemia is disorder of the blood, where a mutation in the hemoglobin gene causes the red blood cells to take on a rigid, sickle shape. The sickle shape prevents the blood cell from holding as much oxygen as a non-sickle blood cell, thus delivering less oxygen to the body's tissues. The sickle cells also have a tendency to break into pieces and get stuck in small blood vessels. It is an autosomal recessive disease, transmitted when both parents of the patient have a copy of the hemoglobin mutation and each pass on a copy to their child.[2] Sickle cell anemia is more prevalent in some populations, and in the descendants of those populations, where malaria is common, such as sub-Saharan Africa. In America, sickle cell anemia is generally conceptualized as a disease that affects African Americans. Although present treatment of the disease is only able to manage and control the symptoms, our scientist is investigating a new treatment that holds much potential for curing sickle cell anemia, although even if successful, would be quite costly and involved for the patient. Our scientist is interested in understanding sickle cell anemia because it is both scientifically fascinating and causes considerable distress for those afflicted.

Undoubtedly, in understanding a disease, unraveling its physiological connections is important, but not the only feature when developing a comprehensive picture of disease, either when understanding causation or in living with it. If virtue includes trying to understand the situation as comprehensively as possible in order to discern a virtuous path,

[2] A.D.A.M. Medical Encyclopedia, "Sickle Cell Anemia," *U.S. National Library of Medicine*, last modified February 7, 2012, accessed September 7, 2012, http://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0001554/.

then our scientist should not lose sight of the disease's context in characterizing it and developing treatments. For our scientist then, familiarity with the history of sickle cell anemia contextualizing its various social and political features is necessary. Keith Wailoo discusses how interactions between biomedicine and politics shaped the identity of and discourse surrounding the disease and those who suffered from it. First reported by James B. Herrick in 1910 after peering through his microscope and noticing the "large number large number of thin, elongated, sickle-shaped and crescent-shaped forms"[3] in a blood sample taken from a young man recently arrived from the West Indies, sickle cell anemia gained increasing attention in the early part of the twentieth century as medical science rendered what was previously invisible, visible. Several years after Herrick's report, theories began to form regarding the population sickle cell anemia affected and it transmission. These theories speculated the disease occurred only in the African American population, that it was a problem that characterized "Negro blood," passed through the generations following the Mendelian rules of dominance.

The tendency for the blood cells to sickle was found in many people, even in those who did not suffer from any of the symptoms, leading physicians and researchers to conclude it was a latent disease, a ticking time bomb that could develop into the full-fledged disease at any time. Because the inheritance pattern was assumed to be dominant, many in the white population feared the disease would spread through miscegenation and come to prevail in the white population after several generations. The concept of Negro blood and sickle cell anemia encapsulated not only emerging technologies and techniques,

[3] James B. Herrick, "Peculiar Elongated and Sickle-Shaped Red Blood Corpuscles in a Case of Severe Anemia," *Archives of Internal Medicine* VI, no. 5 (November 1910): 519.

but also served as a space for debates about race and social order, debates that spanned the dangers of miscegenation, the problems sickle cell posed for the industrial worker, and how blood became a definitive characteristic of one's racial identity.[4] The diagnostic tools set the stage for the debates, supporting perceptions of the African American population as posing threats to the white population and participating in a larger public conversation centered around racial identity and segregation.

However, the construction and understanding of sickle cell anemia shifted in the mid-twentieth century, precipitated by developments in science and changing social and political climates. Using electrophoresis, Linus Pauling characterized sickle cell anemia as a molecular disease caused by some mutation on the hemoglobin molecule.[5] V.J. Neel posited, and was confirmed by hemoglobin studies of families, that sickle cell anemia was homozygous recessive, while a heterozygous inheritance (the child inheriting one copy of the mutated hemoglobin and one copy of the normal hemoglobin) resulted in the blood's capacity to sickle, but not develop the disease.[6] Thus for someone to develop the disease, they needed to have inherited two copies of the mutation. Sickle cell anemia shifted from being a problem of the blood to a molecular problem of hemoglobin. By presenting convincing evidence contradicting the previous construction of sickle cell, the novel technology of electrophoresis moved the discourse away from thinking of blood as

[4] Keith Wailoo, *Drawing Blood: Technology and Disease Identity in Twentieth-Century America* (Baltimore, MD: Johns Hopkins University Press, 1999), 145-149.

[5] Linus Pauling, Harvey A. Itano, S. J. Singer, and Ibert C. Wells, "Sickle Cell Anemia, a Molecular Disease," *Science* 110, no. 2835 (November 25, 1949): 546-547.

[6] James V. Neel, "The Inheritance of Sickle Cell Anemia," *Science* 110, no. 2846 (July 15, 1949): 64.

indicative of race and instead reframed the discourse in terms of molecular conceptions of blood.

While a molecular conception of sickle cell disease worked against notions linking blood and race, the focus on the disease as molecular in nature began to overshadow other facets of the disease, namely the patient's experience. Excitement grew over what molecular biology could find, how molecules could be manipulated in the future and what that might hold for individuals and society. Sickle cell anemia was seen as the window into that exciting world. The discussions over sickle cell came to be more scientifically oriented, focused on the potentials of molecular biology, and began to lose sight of developing treatments for the patient. Sickle cell patients "were now at the locus classicus of scientific literature and therefore were useful in extending areas of scientific investigation—and in shaping the careers of the researchers in those fields... These sufferers became valued, at least in part, because of the way they legitimated research agendas. Sickle cell patients could be studied by geneticists, pediatricians, hematologists, and pathologists as they struggled to develop the insights of molecular biology in their own fields."[7] Thus while Pauling's and Neel's discoveries worked to discredit older conceptions of blood and race, they developed their own host of issues about science and technology's relationship with the patient.

Given this brief overview of sickle cell anemia's medical complications and its problematic history, problems where the scientific and technological developments are intertwined with social and political issues in the construction of the disease, how should

[7] Keith Wailoo, *Dying in the City of the Blue: Sickle Cell Anemia and the Politics of Race and Health* (Chapel Hill, NC: University of North Carolina Press, 2001), 117.

our scientist frame and develop her work in looking for a treatment the disease? To be virtuous, specifically with respect to practical wisdom, our scientist can seek to understand the myriad of ways and consequences physiologically grounded conceptions of sickle cell anemia have been used in their past constructions and the potential implications of possible future constructions for the public and for individuals. She should keep in mind the disease's implications, for individuals and society, and try to shape her work in a way that acknowledges and attends to its context, even though the scientist is focusing on developing a physiologically based treatment for sickle cell anemia. Another way of contextualizing the disease is to identify the various groups affected by the disease, such as the individual, the family, the community, and society, to imagine their various relationships with the disease, and to see how her potential treatments could converge with each of those groups. However, how is the scientist to think through her work that includes these factors? What should she think about and how can these considerations shape the direction of her work?

The features that make up *phronêsis* and how it may work to help the scientist contextualize her work must be further discussed. We must develop a robust conception of *phronêsis* in science before we can explore how the humanities can contribute to its cultivation. In this chapter, I expand upon *phronêsis* by examining its different features and how they help the moral agent deliberate through a situation. I then turn to other bodies of literature that are outside of virtue ethics and *phronêsis*, but have considerable overlap with *phronêsis*. Specifically I discuss reflective practice and moral imagination and how they relate to and expand upon *phronêsis.* Using the example of sickle cell anemia, I will illustrate how a robust conception of *phronêsis* may fit within scientific practice and what it may illuminate in developing a more contextualized science. An in-depth exploration of *phronêsis* will help bring forth the various ways it can factor into scientific practice and what this conception of *phronêsis* requires if science is to be practiced virtuously.

More on Phronêsis

As discussed in the previous chapter, *phronêsis* is the ability to deliberate well, guiding the moral agent through difficult choices and actions. To elaborate further on *phronêsis* and what it entails, it may be helpful to distinguish *phronêsis* from one of the other intellectual virtues—*epistêmê*, which roughly translates as universal knowledge, whose truth does not rely upon situational circumstances. A rectangle is always composed of four right angles, no more, no less, regardless of where it is located, its size, or whether or not someone believes it has those right angles. In contrast, *phronêsis* also seeks truth, but its truths are much different from *epistêmê* in that it lacks universal certainty. With *phronêsis,* the knowledge gained is dependent upon a situation's circumstances, nuances, and contingencies; what may hold true for one situation may not hold true for another one, even if they share similarities. In this way, Aristotle recognizes that ethics is different from mathematics. Truths in mathematics are absolute and unyielding; regardless of the situation, they retain the same characteristics. Depending upon the situation, a certain truth in mathematics may not be applicable, but will still be true. A rectangle still has four right angles even though the problem is only concerned with spheres. However, with ethics such precision is not possible because "ethical principles are in an important sense 'uncodifiable.' One may be able to give a rough general characterization of what it is to be just, according to which actions in certain unproblematic cases can be seen to be just or unjust. But for every such specification there will be other cases in which the justice of the actions cannot be seen from the specification."[8] The same types of truths formulated for mathematics cannot be formulated for ethics because most issues cannot be reduced to a few universal principles that work for every situation. One line of reasoning that works for one situation may not work for another, where the differences between the situations lie in their specific details. This discernment of particulars will help guide the moral agent towards understanding a situation and appropriately responding.

Thus for our scientist working on sickle cell anemia, she must balance the *epistêmê* kind of knowledge, such as its inheritance pattern, its physiological mechanisms, and its manifestations, with the context-dependent knowledge associated with her research. As the task of science is to identify and understand unifying principles that are widely applicable, regardless of situation, *epistêmê* is inherent to scientific research. Our scientist is, and ought to be, concerned with furthering that kind of universal knowledge. However, in developing a robust understanding of the disease, our scientist needs to decide which of the disease's nuances are relevant, such as the recurring painful episodes, its hereditary component and how that worked to define the disease in the past, and the various burdens of the ongoing treatment of symptoms, amongst others. While our scientist can turn to looking at other diseases that share some of these components, they will likely only provide her with a rough idea of the relevant details. Our scientist must decide for herself what she

[8] Norman O. Dahl, *Practical Reason, Aristotle, and Weakness of the Will* (Minneapolis, MN: University of Minnesota Press, 1984), 79.

believes the relevant details to be and understand how they contribute to how she approaches the disease. To help her parse through the details and to help her contextualize her work, she can familiarize herself with how people afflicted and their families cope with the disease, how the potential treatments may or may not fit with their lives or values, or how societal infrastructures can be altered to accommodate them. Paying attention to these contexts can direct the scientist towards pursuing one line of research over another.

While not solely adequate for moral reasoning, general principles do have an important place in a virtue ethics framework. They can serve as useful guidelines for those who lack the discernment necessary to pick out the particulars, helping to highlight a situation's salient features, and can be especially useful in guiding a decision when there is not enough time to carefully deliberate all the features.[9] However, ethical principles are not absolute and can have different interpretations. Appropriate use and interpretation of an ethical principle depends upon the contingencies and circumstances of a given situation. In interpreting principles and the need for occasional flexibility, Stephen Toulmin argues for equity, which "requires not the impositions of uniformity or equality on all relevant cases, but rather reasonableness or responsiveness (*epieikeia*) in applying general rules to individual cases... It means being responsive to the limits of all such formulas, to the special circumstances in which one can properly make exceptions, and to the trade-offs required where different formulas conflict."[10] No matter how solid or extensive a system of rules and principles might be, they will not be able to cover every situation. Interpretation and

[9] Martha C. Nussbaum, *The Fragility of Goodness: Luck and Ethics in Greek Tragedy and Philosophy* (Cambridge, UK: Cambridge University Press, 1986), 304.

[10] Stephen Toulmin, "The Tyranny of Principles," *Hastings Center Report* 11, no. 6 (December 1981): 34.

responsiveness to the principles are needed when making equitable solutions. To appropriately use principles and to see when they do not satisfactorily address the issues requires *phronêsis*, allowing the moral agent to discern which principles could serve as helpful guidelines and to recognize when they may not be completely applicable.

Another facet of *phronêsis* is the role experience plays in its cultivation. Aristotle argues youth cannot have practical wisdom because they lack many life experiences. Experience gives the moral agent personal knowledge of various situations, which she uses to inform her decisions and actions. Unlike the knowledge encompassed by *epistêmê*, this type of knowledge cannot be formally taught and tested, but is cultivated over a lifetime, through trial and error and lessons learned. Taking our scientist, as a novice scientist, she conceptually understood the state of knowledge about sickle cell anemia, the techniques necessary for developing treatment, and so forth. However, she mostly understood them as abstract concepts. Now with some years of experience, she has developed a feel for devising experiments that could lead to possible treatments, for sensing what treatments may be more feasible than others, in terms of scientific feasibility and in terms of how acceptable they would be to individuals and society. Our scientist would remember her past experimental failures, the reasons for their failure, and how she changed directions in response. In this way, *phronêsis* relies upon the scientist's past mistakes to help her avoid similar ones in the future. Her knowledge of sickle cell anemia is now both *epistêmê* and *phronêsis*; she knows the disease in an abstract, conceptual sense, but also has furthered her knowledge of it through experience by investigating various possible treatments.

To further elucidate what *phronêsis* entails, Jana Noel highlights some different features of *phronêsis* by approaching it from three interpretations: rationality, situational perception and insight, and moral character. In the rationality interpretation, the main focus is the reasoning and deliberation a person uses in making her actions and deliberations intelligible within the context of her life.[11] While the reasoning a person uses for explaining her actions is certainly important, the majority of the discussion on *phronêsis* for this chapter focuses on the latter two interpretations.

The situational perception and insight interpretation emphasizes how the moral agent characterizes the situation and how she perceives the possible avenues, how she surveys the lay of the land. In this interpretation, someone with *phronêsis* is someone who "can perceive those possible actions and steps to take and can deliberate through these facets to determine what actions are possible to take on the way to reaching the end of the human good selected."[12] From this interpretation, the person of practical wisdom can hold multiple perspectives of the situation and see the potential actions that would help her reach the good. However, perception must be coupled with discernment, for the moral agent must be able to see the differences and similarities between the multitudes of perspectives and evaluate them. With discernment, the moral agent recognizes the relevant details that may be particular to a certain perspective. Discernment helps the moral agent to arrange and rearrange the situation so it becomes intelligible to her from the various

[11] Jana Noel, "On the Varieties of *Phronesis*," *Educational Philosophy and Theory* 31, no. 3 (October 1999): 275-276.
[12] Ibid., 280.

perspectives. Development of perception and discernment draws largely from the moral agent's past experiences.

For our scientist, this type of discernment is certainly important for her scientific work. She must examine her experiments from various angles to identify their possible strengths and weaknesses. She must interpret her raw data in a way that coheres with itself and the present state of scientific knowledge. But for contextualizing her understanding of sickle cell anemia, there are a multitude of views about the disease that she must work through when trying to develop a treatment. In developing an acceptable treatment, she needs the capacity to see the perspectives of the various stakeholders and the discernment that allows her to decide amongst them. For sickle cell anemia, there are stakeholders, such as those with the disease, their families, society at large, the scientists doing the research, and the funding agencies, which could be either the federal government or private industry. Each has their own interests in seeing a treatment come to fruition, and our scientist must decide which perspectives she wants to shape her research. For example, if faced with different research possibilities, she could decide to pursue the line that was most likely to result in a treatment that was most acceptable to those with sickle cell anemia in terms of balancing its cost, its risks, its burdens, its side effects, and its efficacy as opposed to pursuing a treatment that would generate the most profit or she could pursue a treatment that may be highly efficacious, but also have considerably higher risks and harmful side effects.

However, focusing solely on those in the present does not provide a comprehensive picture when ascertaining perspectives. Part of understanding how things are in the present is to also understand how things were in the past, for the past that provides a backdrop and lays the groundwork for the present. History shows what sickle cell anemia meant to past stakeholders, and how the various stakeholders constructed specific interpretations of the disease to uphold certain beliefs about science and social order. In understanding the perspectives of the stakeholders and in contextualizing her understanding of the disease, our scientist then should be familiar with how sickle cell anemia was part of larger conversations about stigmatization, segregation, and scientific discovery. Sickle cell anemia's past, then, shows not only erroneous beliefs about race and identity, but also demonstrates how one's frame and context can bear significantly on how she interprets her work and what consequences may arise. In perspective taking, our scientist should work to understand her own frame that she works within.

From the moral character interpretation, the moral agent's response to a situation is bound up with who she is as a person, making *phronêsis* dependent upon virtuous character and vice versa.[13] This interpretation gives *phronêsis* a central and crucial position in a person's character, taking it beyond an ability to understand situations and determine appropriate action, but also as telling about the moral agent. A person's character is crucial to how she will frame the situation, what perspectives she discerns, and direct what actions she takes. Virtuous character and *phronêsis* have a reciprocal relationship; *phronêsis* relies upon the moral agent's character as its guide in deliberating and in decision making, while the moral agent's character depends upon *phronêsis* for its expression.

[13] Ibid., 284.

For our scientist then, who she is as a person and how she imagines her *telos* necessarily shapes the various perspectives she factors into her work. So if her *telos* is to make as much money for herself or for her employer, or if her *telos* is becoming a scientist who is highly respected within the scientific community for her insightful contributions to scientific knowledge, she would likely shape her development of treatments differently than if she sought to find ones that were efficacious, cost-effective, with low incidences of burdens and side effects for those with sickle cell anemia. Additionally, if our scientist includes as part of her *telos* developing treatments that work well for most patients' lives, she should remain cognizant to sickle cell anemia's past history of stigmatization and primarily serving scientific interest when conducting her research to ensure she is contributing to construction of the disease that does not demean or erase patients, but keeps their interests at the forefront. In part, this would be based on what kind of scientist she would like to be and become, she chooses how much weight she gives the perspectives in shaping her research.[14]

While these three interpretations of *phronêsis* are certainly intertwined and rely upon each other for coherence, discussing them separately helpfully emphasizes some of the different features that constitute *phronêsis*. The deliberative feature relies upon reasoning that is congruent with the moral agent's life and helps her achieve her *telos*. The

[14] For illustrative purposes, I have deliberately simplified the relationships between the various perspectives. Of course her picture of a well-respected scientist may be one who takes into account the social and moral contexts of her science, not only the science itself. These definitions and interests of the various stakeholders should not be thought of as rigidly bound, but with some overlap. In addition, I have also simplified what would normally be the work of many groups of scientists into one scientist. Most individual scientists do not normally have the option of choosing one treatment to pursue over another, but instead collectively as a group decide what treatment options to pursue.

perception feature focuses on the deliberation that helps the moral agent discern amongst the various perspectives and details. The moral character feature grounds the deliberative and the perception features by necessitating both unfold in congruence with the moral agent's character and *telos*. With *phronêsis*, the moral agent can hold various perspectives and discern their contours, drawing from her past experiences for insight. Her reasoning, her perception and discernment, and her character all guide her through the present situation and contribute to her pursuit of her *telos*.

While cultivating *phronêsis* is necessary for all the various facets of the moral agent's life and the roles she inhabits, most discussions of *phronêsis* are largely housed within larger contexts that examine virtue ethics and pursuit of the *telos* over an individual's life. These discussions do not typically distinguish between the individual's personal and professional life, and while personal and professional spheres of a person's life are not separable, attending to virtue ethics and *phronêsis* from a professional perspective may be illuminating. The role of *phronêsis* in medicine has been discussed by Edmund Pellegrino and David Thomasma in several works[15], but its possibilities for other professions have not been widely discussed. Part of the task of this dissertation is add to the literature that examines virtue ethics and *phronêsis* in professions by envisioning a role

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[15] Pellegrino and Thomasma have written extensively arguing for virtue ethics place in medicine. The following references provide a starting point for looking at virtue ethics and medicine, but are not exhaustive. Edmund D. Pellegrino, "Professing Medicine, Virtue Based Ethics, and the Retrieval of Professionalism," in *Working Virtue: Virtue Ethics and Contemporary Moral Problems*, ed. Rebecca L. Walker and Philip J. Ivanhoe (Oxford, UK: Oxford University Press, 2007): 61-85., Edmund D. Pellegrino, "Toward a Virtue-Based Normative Ethics for the Health Professions," *Kennedy Institute of Ethics Journal* 5, no. 3 (September 1995): 253-277., Edmund D. Pellegrino and David C. Thomasma, *The Virtues in Medical Practice* (New York, NY: Oxford University Press, 1993)., David Thomasma, "Aristotle, *Phronesis*, and Postmodern Bioethics," in *Bioethics: Ancient Themes in Contemporary Issues*, ed. Mark G. Kuczewski and Ronald Polansky (Cambridge, MA: MIT Press, 2002): 67-92.

for *phronêsis* in science and exploring how *phronêsis* could promote a more ethical and reflective scientific practice. To further explore how *phronêsis* can figure into scientific practice, I now turn to other approaches that share many features with *phronêsis*, but frame the agent and her moral development somewhat differently. Specifically, I will next discuss reflective practice and moral imagination and how they intersect with *phronêsis* to illuminate what they contribute to scientists' cultivation of *phronêsis*.

An Expanded View of *Phronêsis*: Reflective Practice and Moral Imagination

The discussion of *phronêsis* in the previous section helps characterize its features and the requirements that the moral agent must meet when developing it. This section further builds upon that discussion of *phronêsis* by examining two other frameworks that have features which share significant resemblances to *phronêsis*, but also bring in other characteristics that can be used to develop a robust conception of *phronêsis*. Specifically I will discuss reflective practice and moral imagination and what they can contribute to *phronêsis*. Reflective practice highlights the importance and role of reflection for the expert practitioner, and can be used to elaborate upon the reflective component of *phronêsis*. It argues for the importance of a reflective space as part of a professional's development. Moral imagination helps the moral agent imagine the perspectives and standpoints of the other stakeholders and empathize with them, despite her lack of directly previously experiencing the other perspectives. In a way, it requires the moral agent to develop the capacity to imagine both laterally and longitudinally. Laterally, by requiring her to imagine herself in other's situations, and longitudinally, by requiring her to hold a conception of her future self and make decisions that allow her to fulfill that conception.

Both contribute to developing the moral agent's character by providing tools that she can use when working through difficult situations. While both reflective practice and moral imagination share features with *phronêsis* and each other, this discussion will highlight how they can develop a robust conception of *phronêsis*.

Reflective Practice

The idea of reflective practice was most extensively articulated by Donald Schön, who discussed its role in professional life generally. Schön argues that skilled practitioners, in general, know more about their work than they usually can articulate when discussing it. They develop an intuitive, tacit understanding of their work that extends beyond the technical components that are explicitly taught to those first learning the practice. This intuitive sense guides experienced practitioners through their work as they do it, a process Schön terms "reflection-in-action."[16] Skilled practitioners think about their actions as they do them, adjusting as necessary to achieve the best performance. To illustrate, Schön uses the example of the baseball pitcher who must adjust his technique for that particular game as the game unfolds. Baseball pitchers talk about needing to "find the groove" in order to pitch well in a game; they do not expect to be able to control a game using the same technique as when they started the game. Instead they adapt their skills to the rhythm and nuances of that game, as well as to the strengths and weaknesses of the other team. These types of adjustments require the pitchers to be aware of both their opponent's skills and their own as they play, and adapt accordingly.

[16] Donald A. Schön, *The Reflective Practitioner: How Professionals Think in Action* (New York, NY: Basic Books, 1983), 49-69.

When reflectively considering the situation in action, the practitioner holds something like a conversation with the situation. While doing the action, the practitioner appraises the situation, acts, and then reappraises, continuing this cycle to her satisfaction. Through continued reappraisal, "the situation talks back. The practitioner, reflecting on this back-talk, may find new meanings in the situation which lead him to a new reframing."[17] In this way, doing and thinking are not separate activities, but complementary and ongoing. Through this conversation, the practitioner responds to the features of the situation by experimenting with possible lines of inquiry and their outcomes. Schön divides these experiments into three overlapping categories: exploratory, move-testing, and hypothesis testing.[18] Through these experiments, the practitioner can undertake an action to see what will follow, without expecting a particular outcome (exploratory), can act with an end in mind (move-testing), and act to discriminate between competing hypotheses (hypothesis testing). These experiments allow the practitioner to explore the contours and the boundaries of the problem, to develop a feel for the situation. The reflective practitioner revisits the features of the situation and experiments with various alternatives to see how the situation changes or to pursue another course.

Our scientist, to an extent, already engages in reflective practice when working through an experimental problem. For example, if using a finicky piece of equipment for her research, she must be able to adapt and problem solve as issues arise to keep her experiment on track and generate reliable data. But she also must be a reflective practitioner in planning and interpreting her research. For these stages, the reflection helps

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[17] Ibid., 135.
[18] Ibid., 145-147.

her understand and shape her research, both in the present and for the future. Reflective practice in the more abstract, less immediately action oriented instances still involves holding something like a conversation with the situation. For example, in keeping patients' interests at the forefront of planning her work, she should periodically assess if the present direction of her research could fall into some of the disease's past problematic constructions. If her goal is to develop a treatment that fits with the lives and values of those afflicted, she must reflect upon her perspectives of sickle cell anemia and revise them to takes the patients' perspectives into account. She can do this by revising her own understanding of and approach to sickle cell anemia based on the various perspectives she encounters.

While reflection during action and appropriate adjustment is important, reflection after action is also crucial. By reflecting after action, the practitioner retroactively examines how she responded to see how a problem could have been handled differently or to see how previously overlooked details could have factored into her performance. Although Schön mostly concentrates upon reflection-in-action, reflection after a decision has been made and an action has been done is also vital to improving the practitioner's future performance. It allows the practitioner to become aware of additional features of the situation that she overlooked while doing the action, hopefully improving her capacity to reflect and respond in future situations. Both types of reflection can be important for any practitioner, but reflection-after-action is particularly important for the novice because it can make explicit the features she overlooked (features that a skilled practitioner likely would not have overlooked) while doing the action. For our scientist, reflection-after-action better prepares her for the next encounter. In trying to develop an acceptable treatment for those with sickle cell anemia, she may have overlooked some pertinent details, such as the treatment regimen being too burdensome or too costly. In reflection-after-action, to understand why the treatment failed, she could retroactively see that she lost sight of the patients' needs in her excitement over her research, resulting in a treatment regimen that unacceptably disturbed patients' lives. In retrospect, she could realize that was a factor in the treatment's failure and resolve to keep patients' interests and needs a priority for future developments. By becoming aware of details previously missed, she gains insight and experience that she can draw upon later and becomes better equipped to work towards picking up on similar details in future situations. Both reflection-in-action and reflection-after-action are important for the novice practitioner's development into a skilled, experienced practitioner.

While the practitioner holds something like a conversation with the situation during reflection-in-action, these interactions with the situation in reflection-after-action are limited. With reflection-after-action, the practitioner no longer converses with the situation as the previous attempts fail. She can only examine the situation retroactively. Additionally, the practitioner cannot experimentally test various actions and see their outcome after the situation has passed; at this point, she is limited to thought experiments as the way to envision other possibilities. Despite the lack of conversation with the situation, this should not prevent the practitioner from revisiting the situation. Sometimes a certain distance is needed in grasping the intricacies of a situation, particularly for the novice. In many instances, no clear distinction between reflection-during-action and reflection-after-action exists. Even when decisions are made and actions are taken, the situation is not necessarily over, but changed, requiring renewed reflection and deliberation. Additionally, the experiments and conversations with the situation may occur over a prolonged period of time, in fits and starts, instead of continuously. Determining when the situation comes to a close may be difficult, but roughly dividing reflection into during or after action helpfully illuminates their different contributions to developing a reflective capacity.

With this sketch of reflective practice, we can turn towards exploring how it may be useful in expanding *phronêsis*. Since reflective practice shares considerable overlap with *phronêsis,* I will only mention them briefly. Like *phronêsis*, reflective practice requires the capacity to distill large amounts of information, bring forth the relevant and important details, and hold a multiplicity of perspectives, all of which are grounded in and developed through experience. The reflective practitioner sees not only one solution to a problem, but many possibilities and evaluates amongst them, examining the situation from multiple perspectives. Developed through experience, the reflective practitioner builds a repertoire of examples, images, understandings, and actions to use when confronted with a new situation. When figuring out a new situation, an experienced practitioner, "*sees* it *as* something already present in his repertoire. To see *this* site as *that* one is not to subsume the first under a familiar category or rule. It is, rather, to see the unfamiliar, unique situation as both similar to and different from the familiar one, without at first being able to say similar or different with respect to what."[19] This practitioner draws upon past experiences to see

[19] Ibid., 138.

what is familiar about this situation and what is not. The familiar can provide her with a starting point to understanding and unraveling the situation.

In summarizing what reflective practice entails, skilled practitioners have the ability to seamlessly reflect upon their work while they continue to do the work, adjusting as they proceed. This skill at reflection is apparent in "[the practitioner's] selective management of large amounts of information, his ability to spin out long lines of invention and inference, and his capacity to hold several ways of looking at things at once without disrupting the flow of inquiry."[20] Reflective practice shares considerable overlap with *phronêsis*; indeed for our purposes, reflective practice may be thought of as a critical component of *phronêsis*, but not necessarily as something distinctly separate from *phronêsis*. Then why discuss reflective practice? I discussed reflective practice in detail because I think it helpfully highlights and makes explicit some of the overlooked reflective components of *phronêsis* that can be important in developing a virtuous science.

Schön's characterization of reflection as resembling a conversation, the need for reflection during and after action, the differences between the timing of the reflection, and the importance of developing the capacity to make adjustments as a situation unfolds, gives more specificity and guidance to the moral agent when she is trying to find the relevant details and decide between multiple perspectives. While *phronêsis* largely focuses on developing the capacity to find a virtuous path by articulating what *phronêsis* entails, it does not fully explore how the moral agent can develop that capacity. *Phronêsis* gives the moral agent the means to cultivate her virtues, but guidance in developing those means is a

[20] Ibid., 130.

bit lacking. And while *phronêsis* can be characterized as an intellectual virtue that enables the development of the moral virtues, this distinction in a way separates thinking through a situation from participating in the situation. However, reflective practice fleshes out the reflective component of *phronêsis* by making explicit the need for fluidity and flexibility in working through a situation, developing the capacity to respond to the situation's contours. While some argue that reflecting on a situation can paralyze action, Schön counters that thinking and doing are necessarily intertwined. He argues, "doing and thinking are complementary. Doing extends thinking in the tests, moves, and probes of experimental action, and reflection feeds on doing and its results… When a practitioner keeps inquiry moving, however, he does not abstain in order to sink into endless thought. Continuity of inquiry entails a continual interweaving of thinking and doing."[21] By framing reflection-in-action as a type of conversation, by emphasizing the experimental component of reflection, by requiring the practitioner to respond to the contours of the situation as it unfolds, reflective practice makes explicit how intertwined thinking and doing are and emphasizes the importance of flexibility and openness on the practitioner's part.

This discussion of reflective practice more fully explains the types of reflection the moral agent may undertake and the characteristics of that reflection when developing *phronêsis*. Although developing specific steps and guidelines for cultivating *phronêsis* in all situations is impossible, this discussion of reflective practice helpfully gives more definition and structure to what the reflection required by *phronêsis* might look like. In general, reflection upon action creates an opportunity for the practitioner to "surface and

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[21] Ibid., 280.

criticize the tacit understandings that have grown up around the repetitive experiences of a specialized practice, and can make new sense of the situations of uncertainty or uniqueness which he may allow himself to experience."[22] By becoming explicitly aware of her intuitive knowledge, the practitioner can better identify the areas that she can consciously work on for improvement. Although the reflective practitioner may not be able to fully articulate her intuitive knowledge, the reflection allows the "inquirer to criticize and restructure his intuitive understandings so as to produce new actions that improve the situation or trigger a reframing of the problem."[23] Reflection gives the practitioner a critical perspective that could potentially change the way she conducts her practice.

Moral Imagination

For moral imagination, Mark Johnson argues imagination is a critical, but often overlooked, component in moral frameworks and reasoning. He describes moral reasoning as "basically an imaginative activity, because it uses imaginatively structured concepts and imagination to discern what is morally relevant in situations, to understand empathetically how to experience things, and to envision the full range of possibilities open to us in a particular case."[24] An imaginative approach can help us better understand our own moral structure, including its values, limitations, and blind spots.

In addition to helping us criticize and illuminate our moral structure, moral imagination creates a space for knowledge, both of self and other, and to criticism. In seeing and evaluating various avenues, the ways we discern between them and the decisions

[22] Ibid., 61.
[23] Ibid., 277.
[24] Mark Johnson, *Moral Imagination: Implications of Cognitive Science for Ethics* (Chicago, IL: University of Chicago Press, 1993), ix-x.

we make bear upon our characters, both present and future. Moral imagination helps us see how

> various actions open to us might alter our self-identity, modify our commitments, change our relationships, and affect the lives of others. We need to explore imaginatively what it might mean, in terms of possibilities for enhanced meaning and relationships, for us to perform this or that action. We need the ability to imagine and to enact transformations in our moral understanding, our character, and our behavior.[25]

Moral imagination helps us reflect on our held values and assumptions by envisioning the results and meanings of possible actions. It is the ability to see a multiplicity of perspectives and choices for a situation and discern their potential consequences. Similar to reflective practice and *phronêsis,* moral imagination entails holding many perspectives of the same situation, seeing the possible consequences, and deciding amongst them. However, it reframes these, bringing forth other facets. Moral imagination is essential not only for the expert practitioner, but also for critical understanding of the self and others and a potential impetus in shaping character.

In this sense, moral imagination plays an important role in the practitioner's moral development. Imagining the range of possibilities and consequences also requires the practitioner to reflect upon her own values and assumptions, similar to the moral character interpretation of *phronêsis*. She cultivates sensitivity towards "the concerns, feelings, prospects, and abilities *of [herself]*. As such, perspective taking in no way implies an objective or detached sympathy. Instead, it is poignantly self-critical and reflective."[26] When imagining how another stakeholder may view the situation, the moral agent must

[25] Ibid., 187.

[26] Dennis J. Moberg and Mark A. Seabright, "The Development of Moral Imagination," *Business Ethics Quarterly* 10, no. 4 (October 2000): 855.

also become aware of the approach she takes and what values and assumptions she brings with that approach. In this way, the moral agent does not evaluate the situation in a detached manner, but is deeply involved. Indeed the self is inherently involved in moral imagination when exploring possible decisions and weighing their potential outcomes. For our scientist then, the perspectives she envisions for others and the ways she responds to them contributes to her moral development. By opening herself to the perspectives of the various stakeholders, she cultivates her moral sensitivities when carefully and thoughtfully work her way through each one's nuances.

Moral imagination also contributes to cultivating the self when choosing one path over the other possibilities. Decision making, particularly within a virtue ethics context, entails not only weighing a variety of options and their possible outcomes, but also involves what Moberg and Seabright call self-sanctions and the imagining of the future self. Through moral imagination, the practitioner can envision future, or possible, selves. These are "individuals' notions of who they could be as moral persons. They embody moral ideals, aspirations, fears, and obligations… Moral imagination affects self-sanctions by creating, activating, and elaborating possible moral selves. In all three of these processes, reflection is the bridge between the contemporary situation and the moral ideal."[27] Similar to the moral agent's *telos* in virtue ethics, moral imagination requires a conception of a future self that the present self would like to become. To even start developing one's *telos*, the moral agent must first imagine how she would like to have lived her life. She projects into the future what she hopes her life will and will not include and only then, can she

[27] Ibid., 868.

begin to work towards fulfilling her *telos*. Thus in decision making, the moral agent is in part guided by how she imagines her future self; she rejects the options that do not fulfill that vision and considers the options that help her meet it.

For our scientist then, the way she practices science is shaped by what kind of scientist she would like to become. If she would like to be a leading figure for a particular technique, she should study the existing literature, practice the technique until she masters it, and work to further science using that technique. However, for our purposes, the way she contextualizes science also should work towards fulfilling her conception of her future self. If she envisions herself as someone who not only produced sound science, but did so in a way that was sensitive to her coworkers and colleagues, to the next generation of scientists, to those she was trying to help, and to the public in general, then she should shape her research and life in a way that places these perspectives as priorities when she decides the next step of her work. Her long-term goals shape the way she shapes and pursues her short term goals.

Thus, since imagination does play a large role in moral reasoning and moral development, we should more closely examine imagination's role in cultivating and complementing *phronêsis*. For *phronêsis,* we need an imaginative capacity in envisioning the different possibilities, evaluating their possible consequences, and in choosing one path over another. Moral imagination elaborates on the need for the moral agent to step outside her own perspective and values in assessing a situation. For the moral agent to be able to simultaneously hold several perspectives, devise creative solutions, or experiment with various lines of inquiry, she must develop an imaginative capacity towards her work, including contextualizing its social, cultural, and political features. Mark Johnson argues, "[o]ur ability to criticize a moral view depends on our capacity for imagining alternative viewpoints on, and solutions to, a particular moral problem. In order to adapt and grow, we must be able to see beyond our present vantage point and to grow beyond our present selves. We must be able to imagine new dimensions for our character, new directions for our relationships with others, and even new forms of social organization."[28] Imagining alternative perspectives involves considering the values, assumptions, worries other stakeholders bring to the situation, and by constructing scenarios factoring in different details and values and trying to envision what might ensue.

Importantly, moral imagination differs from *phronêsis* and reflective practice in their emphasis on the importance of experience for their development. While experience for cultivation of moral imagination is important, for experience helps the moral agent decide upon the salient details and discern between them, experience is not as central. Moral imagination can still be cultivated even if the moral agent has not had direct experience with a particular situation. Because imagination allows the moral agent to inhabit another perspective, some sort of identification or empathetic imagination, with that other perspective is necessary to help the moral agent understand it. In helping the practitioner imaginatively explore various perspectives, moral imagination entails developing her capacity for empathy. Empathy requires an imaginative projection of the self into the perceived experience and feelings of other people. An empathetic practitioner identifies with the feelings of others involved, not in a detached, objective sense, but in a

[28] Johnson, *Moral Imagination*, 203.

way that resonates with her. She is able to imagine the views of the other stakeholders and what the possible outcome might mean to them. Imagining and identifying with the other stakeholders' concerns and values helps the practitioner inhabit their space, connecting the practitioner with them in a way an objective analysis of the situation does not. And in this way, empathy alleviates somewhat the necessity of experience in understanding another's experience. Experience and empathy work in tandem in imagining the perspectives of others.

Identification with others is greatly aided if the moral agent experienced something in her past that resonates with her when she imagines other perspectives. In this way, past experience is an important component of moral imagination. However, with empathy, experience becomes less important because to understand and empathize with another's situation, the moral agent does not need to have once been in the same position. Moral imagination takes the moral agent beyond the boundaries of her direct experience by enabling her to imaginatively discern the features of perspectives that resonate with her own values, desires, and goals. Thus, our scientist does not need to suffer from sickle cell anemia to know that the recurring painful episodes are disruptive and distressing. To identify with their plight, she could draw upon her past memories of pain and illness to imagine what life would be like if suffered from them regularly and had to be constantly worry that another episode may beset her. But to understand why developing treatments for sickle cell anemia is good, she does not need to actually suffer from the disease, but imagine what her life could be like when constantly confronted by this painful, disruptive, lifelong disease.

Clearly, moral imagination plays a critical role in cultivating virtue, specifically *phronêsis* for my purposes. Moral imagination is necessary in developing the self, in evaluating between various courses, and in foreseeing their possible consequences. In short, moral imagination is "the means for going beyond our selves as presently formed, moving transformatively toward imagined ideals of what we might become, how we might relate to others, and how we might address problematic situations. Moral imagination is our capacity to see and to realize in some actual or contemplated experience possibilities for enhancing the quality of experience…"[29] For the practitioner who aspires for excellence in both her professional and personal life, a robust moral imagination helps her cultivate *phronêsis* and reflective practice. By framing the envisioning of multiple perspectives as imaginative and empathetic acts, moral imagination requires the moral agent to connect with the alternate perspectives in ways that are not objective or detached, but resonates with her own perspective. Moral imagination plays a critical role in decision making and in her moral development and is an important component in helping the moral agent fulfill her *telos*. However, moral imagination places less emphasis on experience than *phronêsis* and reflective practice, arguing empathy can supplant experience in trying to see the situation from multiple perspectives.

Conclusion

With this exploration of *phronêsis*, reflective practice, and moral imagination, how can these frameworks help our scientist practice a virtuous science? In this chapter, I have tried to comprehensively discuss the various features that characterize *phronêsis* and the

[29] Ibid., 209.

contributions of reflective practice and moral imagination. I have focused in detail upon *phronêsis*, instead of discussing other virtues important to science, to explore how contextualizing their research can have an important role in its form. *Phronêsis* enables the scientist to practice science well, to pursue a *telos* that encompasses producing knowledge that is scientifically sound and responsive to its larger contexts. With its requirement to look at the situation from multiple perspectives in order discern the relevant features, *phronêsis* gives the virtuous scientist the capacity to examine her work within its many scientific, social, and moral perspectives. The virtuous scientist must look at her work as historically, politically, morally, and scientifically embedded and explore its relationships with those overlapping spheres. In understanding the social and moral dimensions of her work, the frameworks of *phronêsis*, reflective practice, and moral imagination help the scientist better understand the other stakeholders' values and goals. Understanding in this way is abstract and conceptual, to an extent. But the frameworks discussed also require our scientist to connect with the other perspectives in a personal way, because the ways she decides amongst them constantly involves who she is as a person and who she would like to become. She not only imagines the perspectives of others, but tries to inhabit them the best she can in order to discern the relevant features. She imagines the goals and values of the various stakeholders, such as a cost-efficient treatment with manageable risks and side effects, a profitable product, or generalizable knowledge about natural phenomena. Guided by her experience, her empathy, her values and her *telos*, our scientist works to understand stakeholders' perspectives and discern her virtuous path amongst them. *Phronêsis*, moral imagination, and reflective practice all emphasize the need for attending to the details of a situation. They help our scientist see the larger context by requiring her to envision as many angles of a situation as she can, using various methods and approaches, and to discern between them. How she chooses her virtuous path depends on who she is presently and who she would like to become. So if our scientist believes science should be practiced without attending to its larger context, she might see her research only as the means to finding sound knowledge that benefits the scientific community. But if she believes a scientist's role is broader than that, that because science is an enterprise with significant ramifications beyond the production of knowledge, then she should shape her research in a way that attends to the larger context.

To develop a science that attends to its moral and social dimensions, scientists themselves must incorporate these values into their identities as scientists. While the cultivation of *phronêsis* is rooted in experience, empathy, and imagination, the scientist need not rely solely on her wits and thoughts to develop her capacity to understand and relate to other perspectives. The humanities can help the scientist expand her understanding of a situation, possibly to an extent greater than what she may accomplish on her own. In developing a virtuous science and the imperative to reflect upon science's moral, social and cultural implications, scientific practice can develop a collaborative relationship with the humanities, where the humanities help scientists further cultivate *phronêsis*, reflection, and moral imagination by offering additional insight or interpretations of a situation. The humanities can illuminate science's moral features, serve as a guide when trying to untangle them, and examine the effect of scientists' character upon their practice of science. Using examples from history and literature, the next section of chapters argue that the scientist's character and the scientist's reflection upon her work are critical in developing a responsible scientific practice. It will also discuss how the humanities can serve as a resource for grappling with science's various ethical challenges. It makes an argument for how the humanities can enrich scientific practice in a way that could lead to a more reflective and contextualized practice of science. Particularly by drawing upon the humanities to augment their empathy, their moral imagination, and their capacity to understand other perspectives, the next section argues that for scientists to cultivate a responsible, virtuous science, this requires them to reflect on the possible consequences of their work.

Chapter 4: The Ordinary Scientist

In the first three chapters, I discussed some features of science and society's complex relationship, the responsibilities engendered by that relationship that scientists must address, virtue ethics as a framework for working through science's moral and social features, science as a practice, and the development of *phronêsis,* reflective practice, and moral imagination. As science and society both have considerable influence over the shape and form of the other, scientists have obligations to reflect on that relationship and contextualize their science within its social and moral features as part of practicing science well. By placing the moral agent and her character in the center of moral reasoning and actions, virtue ethics provides a framework for the scientist that directly connects the scientist's character with appropriate action. Virtue ethics' focus on cultivating the right character necessary when pursuing and fulfilling the *telos*, for both individuals and for practices, emphasizes the importance of one's character for a life well-lived. Although the scientist will face many different moral and social complexities related to her work over her career, her character, which encompasses her desires, motivations, reasons, decisions, and actions, will guide her through a multitude of situations. The moral agent's character and her *telos* are closely intertwined, with the *telos* stemming from the moral agent's character and the moral agent shaping her character in a way that enables her to pursue her *telos*. The moral agent must cultivate her character so the values, virtues, and habits necessary for her *telos* become incorporated into who she is.

While the typical *telos* for science is to understand the natural world according to physical laws, for science to be practiced responsibly and ethically, scientists should craft their science with an awareness about the larger implications and possible effects of their work and science. In realizing this broadened *telos* for science, cultivation of the scientist's character should encompass addressing and understanding science's and society's mutual effects. To realize this multifaceted *telos* for science, the scientist must strive to expand the scope of her *phronêsis*, moral imagination, and reflective practice to encompass ethical, responsible, and scientifically sound research. In producing scientific knowledge, the scientist's character plays an important role in how she approaches her research, how she determines its direction and execution, and how she treats and presents the resulting data. Similarly, in considering her work's social and moral features, the scientist's character informs what she holds to be the relevant perspectives and details, how she contextualizes her work, and how she attends to her own biases and assumptions about her work and its relationship with society. Because of science and society's considerable influence upon each other, scientists' characters have the potential to exert influence over how science is assimilated into society, how science itself is interpreted, and how society is further changed because of science.

To further discuss the development of a scientist's character and how it affects the shape and direction of scientific research, I will turn towards examining history and literature that discuss the values expected of a scientist, the public's fears and hopes regarding science that are reflected in various scientists' characters, and how the real world scientist can benefit from studying these sources in shaping her own understanding and practice of science. Work in literature and history of science, in part, necessarily deals with who the scientist is as a person and how her character shapes the direction and interpretation of her work. When tracing the history of a scientific product or theory, elucidating who the scientists are as people, with their virtues and vices, reveals that their characters are some of the driving forces that bring the product or theory to fruition. Similarly, in a novel, the scientist character, to varying degrees, works to move along the plot and often serves as the embodied form of scientific practice, housing its values and norms within a fallible person. Thus, when reflecting on the role character plays when crafting an ethical and contextually responsive science, historical and literary sources can prove to be rich resources. Scientists' character is a critical, but often overlooked, component in a scientist's training and scientific practice. Because of this oversight, scientists are not particularly well-equipped to examine the moral and social features of their work or how their character is situated within them. Even if the scientist is well versed in her work's social and moral contexts, the humanities can provide insights and additional dimensions not previously considered by the scientist. Through literature and history, the scientist can imaginatively examine the choices of other scientists and the consequences they entail, whether real or fictional. In this sense, the humanities function to create space for and enable conversation about moral issues.

While virtue ethics and the development of *phronêsis* provide a framework for viewing science's moral and social landscape and help orient the scientist within that landscape, history and literature provide a way for the scientist to explore what virtues she wants to incorporate into her character, particularly those that help her grapple with science's context. Indeed, through history and literature, the scientist can further cultivate *phronêsis*. As discussed in chapter 3, cultivating moral imagination is an important component of *phronêsis*. Stories allow the reader to imagine the motivations, insights, and choices of those in the story without actually experiencing that particular situation herself. In *The Call of Stories*, Robert Coles embraces using novels as an important component for moral development in medical practice, advocating novels and stories as "renderings of life; they can not only keep us company, but admonish us, point us in new directions, or give us the courage to stay a given course. They can offer us kinsmen, kinswomen, comrades, advisers—offer us other eyes through which we might see, other ears with which we might make soundings."[1] Put another way, literature exposes the reader to problems, presenting alternate, yet understandable, ways of interpreting and reacting to them that may differ from how the reader would interpret and react to them. Literature's task is not to depict solutions, but to "aid us in the imaginative re-creation of moral perplexities, in the widest sense."[2] Both literature and history delve into exploring a situation's nuances and connections, tracing how those in the situation see it and why they respond the way they do. Works of literature and history help the reader cultivate *phronêsis* by allowing her to indirectly experience situations and perspectives other than her own, offering admirable characters for emulation, cautionary figures as warnings, or any blend of characteristics that combine in complex, multidimensional characters, which may be real or fictional.

In addition to drawing insight from the stories themselves, examining both historical and literary works can help the reader develop skills of critical analysis by teaching the reader "to read in the fullest sense." This requires the reader to master and

[1] Robert Coles, *The Call of Stories: Teaching and the Moral Imagination* (Boston, MA: Houghton Mifflin, 1989), 159-160.

[2] Hilary Putnam, "Literature, Science, and Reflection," *New Literary History* 7, no. 3 (Spring 1976): 485.

employ skills of literary analysis about the text, raising questions about the narrator, the author, the language, what perspective is being told, and what is left out.[3] For physicians, this helps prepare them for listening to and interpreting their patients' stories. Although most basic scientists will not be tending to patients, they still must hone their interpretive and analytic skills for interpreting and synthesizing their data. Analysis of historical and literature can serve as a type of "academic cross-training." Similar to the way athletes engage in physical cross-training, scientists' cross-training in the humanities "develops a student's ability to collect and organize facts and opinions, to analyze them and weigh their value, and to articulate an argument, and it may develop these skills more effectively than writing yet another lab report."[4] The analytical and interpretive skills developed with literary analysis can also be employed in analyzing and interpreting scientific data. Analysis of historical and literary works nicely supplements virtue ethics by providing a path for cultivating *phronêsis* that does not solely rely upon personal experience.

Through works of literature and history, the reader is privy to the details, the decisions, the strengths and faults, and the oversights of the scientist character and, based upon her interaction with the text, the reader can shape her own perspectives towards the practice of science. Examining historical and literary perspectives of the scientist can help the real-world scientist make decisions that foster a responsible and ethical scientific practice. The different figures of scientists, both real and fictional, can help the real-world scientist identify values and norms she would like to avoid or embody. For the remainder

[3] Anne Hudson Jones, "Narrative Based Medicine: Narrative in Medical Ethics," *British Medical Journal* 318, no. 7178 (January 23, 1999): 255.

[4] Thomas R. Cech, "Science at Liberal Arts Colleges: A Better Education?," *Daedalus* 128, no. 1 (Winter 1999): 210.

of this chapter and the next two, I will discuss various figures of the scientist in literature and through history and examine what they contribute to the real-world scientist's practice. Specifically, this chapter will focus on the figure of the ordinary scientist, while chapter 5 will examine the mad scientist and chapter 6 will discuss the heroic scientist. Regarding the order and relationship of the chapters, perhaps a bit more explanation is needed.[5] Although the discussions of all three figures are considerably intertwined, the decision to discuss the ordinary scientist first comes, in part, from how it is the most directly applicable figure to real-world scientists. Realistically constructed, the depictions of ordinary scientists and their trials make them relatable to the real-world scientist, while the mad and heroic scientists are caricatures that exaggerate various features of the ordinary scientist. In a sense, the ordinary scientist serves as the model that the mad and heroic scientists distort. To better understand the mad and heroic scientists and the relationships between the three figures, an examination of the ordinary scientist is needed. This chapter establishes the character of the ordinary scientist, where the two subsequent chapters distort the ordinary scientist in ways that may initially seem too far-fetched to be useful, but each highlights its own set of issues the real-world scientist faces, which will be later discussed. By first discussing the ordinary scientist, I want to establish the relevance of these figures to real-world scientists by starting with the most relatable and provide a contrasting anchor for the subsequent figures.

[5] In terms of chronologically establishing each figure, the mad scientist was first characterized in the early part of the nineteenth century and the heroic in the late nineteenth and early twentieth centuries. Focus on the ordinary scientist emerged in the latter half of the twentieth century. However, discussion of the scientist as an ordinary person has recurred since the seventeenth century, which will be further explored in this chapter.

In general, the character of the scientist, as depicted in literature and history, falls into three general categories: mad scientist, heroic scientist, and ordinary human being scientist. Although Roslynn D. Haynes has divided the stereotypes of the scientist into seven categories, they overlap each other and roughly can fall under the mad or heroic scientist rubrics. She identifies different variations on the mad or heroic scientist themes, with some mad scientists as deliberately malicious and some unwittingly unleashing powers beyond their control and some heroic scientists as saviors of society and some as intrepid explorers.[6] These different depictions have waxed and waned in popularity at different points in the development of scientific practice. However, in present day, the figures of mad, heroic, and ordinary scientists simultaneously exist in the public's imagination. Understanding the character of the scientist in its historical and literary contexts can serve as a beginning point for the real-world scientist to see how her character affects the shape and direction of her own research. A person's character shapes how she approaches and interprets her work, subtly influencing the questions she asks and the interpretations she forms. The subtle decisions she makes in framing her research question, her methods of gathering data, and her decisions in analyzing and presenting data, all stem from the values she holds and how much flexibility she gives them. Thinking of the scientist as an ordinary person (instead of a heroic or mad caricature) begins to tease apart this idea of how the scientist's character, virtues, vices, and various social and daily pressures intermingle to influence how the scientist practices science. It emphasizes how the scientist's character

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[6] Roslynn D. Haynes, "From Alchemy to Artificial Intelligence: Stereotypes of the Scientist in Western Literature," *Public Understanding of Science* 12, no. 3 (July 2003): 244-253.

cannot be neglected when encouraging ethical and responsible research, but instead is a critical component of practicing science well.

In this chapter, I will focus on the scientist as an ordinary person, someone who is subject to the same daily pressures and social forces as anyone else. I will discuss the housing of scientific values within an ordinary person, drawing from both historical and literary texts. The historical discussion of the scientist's character traces the development of what values the ordinary person needed to embody in order to promote and preserve scientific authority. I will discuss how establishing the scientific character was crucial in delineating science's boundaries, identity, and presence as a legitimate force. While these efforts sought to define the proper boundaries of scientific investigations, they also came to define science's values and norms, and what type of person the scientist must be in order to uphold those values. Thus in the development of scientific practice, the scientist's character played a critical role. Since the seventeenth century, the relationship between the scientist's character and science has changed, with more or less emphasis placed on the interconnectedness between character and science at different times. I will briefly examine those shifts that occurred at certain episodes in the twentieth century. The historical examination of the concerns that surrounded the scientist's character as science develops explores the role of character in setting science's shape and direction and provides a framework for the later explorations of the ordinary, mad, and heroic figures. It is within this ever-shifting space that these figures assume their shape.

This historical development of scientific character lays the ground work for the literary explorations of the scientist's character. The discussion of literary scientists in this chapter will examine the scientist as an ordinary person, with the same flaws and weaknesses as anyone, and how that can sometimes conflict with science's values. In treating the fictional scientist as a believable person, the real-world scientist can explore the inner life of someone with whom they share similarities, seeing the effects that precipitate from the tendencies and dispositions that are a part of the fictional scientist's character. Fictional characters allow the reader to imagine alternate paths and other perspectives, letting her explore how they relate to how she would like to shape her life. These characters begin to illustrate how the scientist's response to small, seemingly inconsequential pressures can eventuate in unethical, or at least undesirable, actions, and how vigilance in this possible slippage can help prevent those transgressions. The figure of the ordinary scientist exposes the very human flaws, habits, and weaknesses that everyone is susceptible to and illustrates their possible consequences for scientific research.

The Importance of Character in the Development of Science

Over the course of the seventeenth century, science began to develop into the form recognized today. Although science had been practiced in various forms prior to the seventeenth century, it was piecemeal, with differing aims, methods, and values. By the seventeenth century, practitioners of science were beginning to coalesce and delineate science's boundaries and ways of producing scientific knowledge. These boundaries encompassed defining acceptable areas of investigation, acceptable types of knowledge, and acceptable ways of arguing for, presenting, and demonstrating that knowledge. This struggle can be epitomized in the opposing voices of Robert Boyle and Thomas Hobbes, discussed at length in Steven Shapin's and Simon Schaffer's book, *Leviathian and the Air-*

Pump. In this work, Shapin and Schaffer describe how Robert Boyle, through his air pump, comes to define the boundaries of science's methods and values by arguing for the legitimacy of experimentally derived knowledge and by developing rules that regulated the character of the scientist and the moral life of the scientific community. Thomas Hobbes stands in opposition to Boyle, "tak[ing] the role of Boyle's most vigorous local opponent, seeking to undermine the particular claims and interpretations produced by Boyle's researches, and, crucially mobilizing powerful arguments why the experimental programme could not produce the sort of knowledge Boyle recommended."[7] Hobbes argued that Boyle's experiments could not possibly produce the "matters of fact" that Boyle claimed. Hobbes argued Boyle began from faulty presuppositions and confused facts with belief—experimenters relied upon assumptions and untrustworthy senses that could not accurately identify the physical cause of the phenomena they observed.

Critical to Boyle's endeavors to establish experiments as a legitimate way of generating knowledge was defining what type of person the experimenter was and laying down rules of conduct for the scientific community. When writing of their experiments, "those who wrote experimental essays were 'sober and modest men,' 'diligent and judicious' philosophers, who did not 'assert more than they can prove.' This practice cast the experimental philosopher into the role of intellectual 'underbuilder,' or even that of 'a drudge of greater industry than reason. This was, however, a noble character, for it was one that was freely chosen to further 'the real advancement of true natural philosophy' rather

[7] Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton, NJ: Princeton University Press, 1985), 7.

than personal reputation."[8] Through the tone of their essays, the experimenters were to present themselves as modest men, who merely wrote to explain natural phenomena they observed as representative of reality. By adopting a tone of modesty and diligence, experimenters presented themselves as hard-working, conscientious, and careful people who sought knowledge for its own sake, instead of for their own advancement.

Boyle recognized the importance of the experimental community presenting itself as composed of modest and reasonable men. Boyle and Hobbes lived in a time of great social and political upheaval during the Restoration, when questions of acceptable assent needed to be resolved in order for the experimental program to thrive. To show the scientific community as modest and capable of assent, Boyle regulated not only how the experimenter presented himself, but also how he interacted with other experimenters. When criticizing another's work, these "[d]isputes should be about findings and not about persons. It was proper to take a hard view of reports that were inaccurate but most improper to attack the character of those that rendered them. . ."[9] A modest and reasonable experimenter should think of another's work as separable from their character. With this, Boyle laid the foundation for the image of the scientist whose character seems distinct from, but is actually intertwined with his work. His attempt to present the scientific community as composed of certain types of men, specifically sober and modest men who work to uphold the social order, belies his attempts to separate them and, instead reemphasizes the importance of the scientist's character. By presenting the scientist as separate from his work, Boyle further reinforces their relationship.

[8] Ibid., 65.
[9] Ibid., 73.

By making disputes about the findings and not the one who did the finding, Boyle allowed for dissent within the experimental community; it was permissible only in this specific and regulated way amongst other experimenters. This particular kind of dissent allowed "the creation and the preservation of a calm space in which natural philosophers could heal their divisions, collectively agree upon the foundations of knowledge, and thereby establish their credit in the Restoration culture. A calm space was essential to achieving these goals."[10] Boyle sought to establish a style of dialogue similar to that advocated by Renaissance humanists for the experimental community. Renaissance humanists, notably Erasmus, conceptualized a style of speaking where "the speakers are engaged in a joint effort to discover the truth. And though each speaker may have tentatively arrived at a point of view, the other interlocutors and their opinions must be accorded full respect. Such mutual respect signals a discussant's readiness to reconsider in light of the others' opinions."[11] Boyle wanted to create a similar type of collegial space where through regulated dissent, assent could calmly and willingly be achieved by all parties.

As the experimental community worked to claim legitimacy for their form of knowledge, through this type of discourse, "it had to be shown how knowledge was connected with public peace; it had to be shown how such knowledge might be produced; and it had to be shown that such communities would not threaten existing authorities such as the clergy or the power of the restored régime."[12] The experimental community presented themselves as a group capable of reaching peaceful consensus on their own,

[10] Ibid., 76.

[11] Gary Remer, "Erasmus: The Paradigm of Humanist Toleration," in *Humanism and the Rhetoric of Toleration* (University Park, PA: Pennsylvania State University Press, 1996), 100.

[12] Shapin and Schaffer, *Leviathan and the Air-Pump*, 284.

through conversation and dialogue about their work. Their identity as sober and modest men made them appear nonthreatening and helped them gain legitimacy within the larger social and political order.

The consideration Boyle gave the scientist's character and its role in favorably representing the scientific community continues to be necessary as science changes over the twentieth century and into the twenty-first. Boyle's insistence on scientific dissent only within a safe space and that dissent as criticizing the work, not the creator of the work, helped establish science as a practice that is separate from society and detached from its practitioners. The detachment Boyle insisted on when representing one's work or criticizing another's has become an important feature of scientific practice. Science since Boyle's time has grown considerably, in size, scope, and authority, and the modest and sober, but tirelessly dedicated image of the scientist that Boyle advocated is sometimes morphed into a mad scientist or a heroic one. Particularly after the atomic bomb, the detachment between a scientist's character and his work that Boyle advocated contributed to the idea of a science gone mad. The scientist's detachment was seen as a part of his madness, a theme I will discuss in much greater detail in the following chapter. On the opposite side of the spectrum was the heroic scientist, whose heroism in part stemmed from other features of Boyle's account of a scientist's character—the scientist's dedication to knowledge and the scientist as an agent for the social good. The heroic scientist's love of knowledge and truth and his willingness to forego personal gain for them in part contributes to image of the heroic scientist as someone who is morally superior and leads an ascetic life. These traits importantly figure into the heroic scientist's character, which will be discussed in much more detail in chapter 6. However, I wanted to briefly mention the opposing images of the mad and heroic scientists in order to point out how they have some roots in the historical development of the scientist's character.

In *The Scientific Life,* Stephen Shapin discusses how the character of the scientist played a critical role in the construction of American science in the twentieth century, particularly as science moved from academia to industry. After World War II, the demand for scientists increased significantly, and those demanding scientists sought them for their expertise as science became increasingly integrated into the structures of power and profit. Many worried that the mad and the heroic images of scientists, which simultaneously existed in the public imagination, would deter able and promising young minds from pursuing a career in science. The scientist began to be refashioned as an ordinary man who has the same traits as every other person, "accept[ing] the morals of the society of which they are a part."[13] The average scientist was neither genius nor madman, but instead an ordinary citizen with perhaps above average intelligence. About the misconception of the scientist's identity, Glenn Seaborg wrote in 1964, "Within their specialties their natural intellectual capacities are greater than the average man's and their trained competence is certainly great, but as human beings they are subject to the same shortcomings, the same wants, desires and drives as anyone else."[14] A different kind of image for the scientists formed, the ordinary scientist, a person who may enjoy science very much, but otherwise is the same as the next person. With the various scientific developments in the twentieth

[13] Steven Shapin, *The Scientific Life: A Moral History of a Late Modern Vocation* (Chicago, IL: University of Chicago Press, 2008), 73.
[14] Ibid., 77.

century, the scientist's moral character became a contested space and was refashioned as ordinary, as a way to attract people to a scientific career and reassure the public.

Although the scientist became characterized as an ordinary person, with regular ambitions and faults, as science continues to change, Shapin argues the scientist's character has become increasingly important. As the twentieth century witnessed the shift of science from academia to industry, it also witnessed the growth of entrepreneurial science. For venture capitalists investing in start-up businesses, the entrepreneur's character is of critical importance. They judge who the entrepreneur is as a person at least as much as they evaluate the entrepreneur's proposition. That is, they "bet on the jockey, not the horse."[15] Because of the uncertainties that venture capitalists face when investing in a new company, the entrepreneur is the most reliable feature: "the entrepreneur in front of you, pitching these claims to investors—if he doesn't go under a proverbial bus or have a radical personality change—*will be there in the investable future*. What you see is very likely what you will get. If he seems innovative, prudent, and professional today, he will very likely be so a year or three in the future."[16] Venture capitalists invest in the person, at least as much as the idea, and the people they fund are motivated by passion, commitment, and vision, not monetary rewards. The entrepreneur's character is critically important, a major factor for venture capitalists. In a way, this reliance upon character is radically different from how Boyle interpreted character's role in scientific practice. However, upon closer inspection, the difference seems to lie with how much explicit acknowledgment is given to the relationship between a scientist's character and work. While venture capitalists openly

[15] Ibid., 289.
[16] Ibid., 290-291.

acknowledge the close connection between who the scientist is as a person and the work he produces, Boyle sought to separate them for establishing scientific authority. Separating the scientist from his work, which has become the *modus operandi* of scientists negotiating new knowledge today, highlights Boyle's concerns about how the scientist was seen by others and underscores the importance of scientists having the right character. The focus on scientists' characters in more recent times merely recasts the role of character in scientific practice, echoing Boyle's concerns about how it shapes science, but instead blurring the distinctions between the work and the person.[17]

Regardless of how a scientist's character overlaps with his work, since the seventeenth century, various people who were invested in establishing and maintaining science as a legitimate practice have worried over the scientist's character and how it shapes scientific practice. Although the scientist's character has shifted over the centuries, as scientific practice changed, the scientist's character continues to be a contested space. Its changes depend upon the purposes of the crafter, whether to secure legitimacy for a form of knowledge, to attract additional numbers to science, or to bet on the most certain feature in an uncertain investment. While it has gone through various permutations and seems to be ever shifting, the attention paid to scientists' character indicates its continued importance in the development of science. Who the scientists are as people and how they

[17] This is only a very brief look at some episodes in the historical development of the scientist's character to illustrate the central role of the scientist's character in practicing science. Much, much more can be said about the historical development of the scientist's character, which has undergone significant changes through the centuries and continues to change. Lorraine Daston and Peter Galison trace these some of these shifts in the scientist's character in *Objectivity* (New York, NY: Zone Books, 2007). In this work they explore how the scientist's character and the values he incorporated, specifically the epistemic virtue of objectivity, changed over time, through the phases they term truth-to-nature, mechanical objectivity, and trained judgment.

present themselves are used as a collective representation of science's character. Thus scientists' characters play a critical role in how science is practiced, for they house and perpetuate the values and ideals of science. However, this discussion of the scientist's character over time has focused on the how the scientist's character *ought* to be or at least how it is perceived, which may or may not be reflected in actual practice. While not exactly idealized (that theme will be discussed in chapter 6), these images lie somewhere between the imagined and the actual. Regardless of how the imagined scientific character changes, the permutations fall within a generally acceptable range of human behavior; this imagined scientist could plausibly be accurate for actual scientists.

With this sketch of how the scientist's character has shifted through history and its continued importance to practicing science, I turn to looking at literary sources that further delve into the ordinary scientist's character. The historical sketch has shown how the scientist's character is and remains an important factor in the development of science, regardless of how that character has changed over time. In contrast, the literary sources are more interested in the inner workings of scientists, how the individuals' characters result in particular decisions, actions, and consequences. They explore the importance of character by delving into how the literary scientists' intentions and motivations shape their work. This brief historical examination of scientific character has shown how the scientist's character is thought to be reflective of scientific practice in general and how it is important for the scientific man to be thought of as an ordinary person. With the literary examination of ordinary scientists, I hope to show a different perspective on the ordinary scientist, specifically as an ordinary person who is subject to the same pressures, weaknesses, and habits as anyone else and reacting in a way that is understandable by the reader.

"Spots of Commonness": Lydgate and Scientific Ambitions

Perhaps one of the first serious treatments of modern physician-scientists in literature is George Eliot's *Middlemarch*, represented by Tertius Lydgate, the enterprising young physician, newly arrived in Middlemarch.[18] Set in the beginning third of the nineteenth century, *Middlemarch* is a careful examination of a provincial town, with multiple interlocking narratives in its wide cast of characters. Eliot creates a realistic novel, where her characters are subtly interlaced within a complicated web of character and circumstances. Some have suggested Eliot brought a scientific eye to this novel, seeing society as something that can be analyzed and scrutinized, similar to a laboratory specimen, with the novelist's task analogous to that of the vivisectionist. While scientists physiologically vivisected their subjects, Eliot psychologically vivisected her characters, experimenting with her characters by controlling their circumstances and their choices, allowing her to observe how their lives unfold. In discussing Eliot's approach, Richard Menke writes, "Eliot appropriates something of the outlook and rhetoric of physiology to construct a fictional character that conveys the impression of being animate, pre-existent, and available for vivisection. Adapted for the purposes of fiction, then, the very techniques that piece apart real living things help Eliot put together lifelike fictitious ones. In fiction,

[18] Of course, physicians have appeared in other works of literature prior to *Middlemarch*. However, in most of these cases, they were painted as frauds or objects of fun, not as admirable characters or ordinary people. In contextualizing Lydgate amongst his literary predecessors, see Patrick J. McCarthy, "Lydgate, 'the New, Young Surgeon' of Middlemarch," *Studies in English Literature, 1500-1900* 10, no. 4 (Autumn 1970): 805-816.

paradoxically to *vivisect* may be to *vivify*." [19] Grounded in believable circumstances and actions, Eliot breathes life into realistic characters and imaginatively experiments with them to examine the complexities and subtleties of society and the relationships it holds.

Eliot explores many themes in *Middlemarch*, such as the status of women, education, and, important for my purposes, medical reform. But she also deftly demonstrates how a person's seemingly small actions are inextricably connected with the actions of others and can culminate in life-altering situations. The metaphor of a web extends through the novel, connecting seemingly unrelated characters and trapping them in ways they do not perceive. The cast of characters is both connected by this web and trapped by it, with their actions sending vibrations to all corners. Although her characters are blind to these connections, Eliot seeks to make these connections evident to the reader, to examine how small, seemingly insignificant actions can have huge life-altering effects, irrevocably changing the direction of a person's life. About this task, Eliot's narrator says, "I at least have so much to do in unraveling certain human lots, and seeing how they were woven and interwoven, that all the light I can command must be concentrated on this particular web, and not dispersed over that tempting range of relevancies called the universe."[20] With this focus in mind, Eliot turns to introducing Tertius Lydgate.

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[19] Richard Menke, "Fiction as Vivisection: G. H. Lewes and George Eliot," *English Literary History* 67, no. 2 (Summer 2000): 646. Émile Zola further extends the analogy between science and novels in *The Experimental Novel*, trans. Belle M. Sherman (New York, NY: Cassell). It is available online at http://ia700304.us.archive.org/26/items/experimentalnove00zolarich/experimentalnove00zolarich.pdf). In this essay, Zola argues how the novelist should function as both experimentalist and observer, that the experimental method for science could be applied to novels.

[20] George Eliot, *Middlemarch*, ed. Bert G. Hornback, Norton Critical Edition. (New York, NY: W.W. Norton, 1977), 96.

Although he is primarily a physician, Lydgate seeks to reform medical practice through scientific means. He is idealistic, ambitious, and ready to dedicate himself to reforming medicine. He seeks to reform medicine in a number of ways, such as prescribing drugs without dispensing them (a change the older generation of physicians opposed) and furthering the scientific basis of medicine, particularly regarding anatomy and pathology. Lydgate sees pathology as "a fine America for a spirited young adventurer. Lydgate is ambitious above all to contribute towards enlarging the scientific, rational basis of his profession. The more he becomes interested in special questions of disease, such as the nature of fever or fevers, the more keenly he felt the need for that fundamental knowledge of structure. . ."[21] In addition to caring for his patients, Lydgate wants to reform medical practice in general, through contributing to the scientific foundation of disease and its causation. In short, Lydgate plans "to do good small work for Middlemarch, and great work for the world."[22]

Despite Lydgate's will and ambition, Eliot warns us early on that Lydgate has flaws that may impede his ambitions, that his character has "spots of commonness." Although Lydgate fully intends to do good for the world, his spots of commonness lie with his prejudices, "which, in spite of noble intention and sympathy, were half of them such as are found in ordinary men of the world: that distinction of mind which belonged to his intellectual ardour, did not penetrate his feeling and judgment about furniture, or women, or the desirability of its being known (without his telling) that he was better born than other country surgeons. He did not mean to think of furniture at present; but whenever he

[21] Ibid., 101.
[22] Ibid., 102.

did so, it was to be feared that neither biology nor schemes of reform would lift him above the vulgarity of feeling that there would be an incompatibility in his furniture not being of the best."[23] Although Lydgate is quite astute in medicine, he has bits of blindness when it comes to matters of women and furniture, and how they may affect his ambitions. For all his ambitions, Lydgate is concerned with his furniture, with his appearances. Lydgate is well-born and wants to appear as such. He wants to appear prosperous, even though he presently is not. However, because of his blindness, Lydgate does not see the problems with appearing to be more prosperous than he actually is and how those desires can morph into obstacles that block his dreams. Similarly, he is blind in matters concerning women. He quite enjoys women and fell passionately in love with an actress prior to coming to Middlmearch, but he is oblivious to how his relationships with them may impede his scientific goals.

However, Eliot takes care to present Lydgate's character as still malleable. He could become a great contributor to scientific medicine, or he could fade into obscurity in his pursuit of material wealth. To Eliot, character is not fixed, but "a process and an unfolding. [Lydgate] was still in the making, as much as the Middlemarch doctor and immortal discoverer, and there were both virtues and faults capable of shrinking or expanding."[24] Lydgate is positioned as at a critical point in his character. The decisions he makes regarding his medical practice, his scientific research, his furniture, and his women should be carefully considered to put him on the path he desires. When Eliot introduces Lydgate, she places him at a crucial place in his life for the fulfillment of his ambitions, but

[23] Ibid., 103.
[24] Ibid., 102.

to achieve them, he must develop the capacity to identify the obstacles (both of his own making and those of others) that may impede him. Once Lydgate starts on whichever path, turning around to explore the other one would be extremely difficult, if not impossible.

As the novel unfolds, Lydgate proves himself a capable and compassionate physician. He builds a reputation as a good doctor. He soon catches the eye of Rosamond Vincy, the daughter of a prominent Middlemarch business man, who sets out to make Lydgate fall in love with her. Rosamond is the epitome of feminine beauty, lovely to look at and displaying only becoming feminine traits, such as elegance and amiability. Lydgate takes her attentions to be harmless flirting: "In fact, they flirted; and Lydgate was secure in the belief that they did nothing else. If a man could not love and be wise, surely he could flirt and be wise at the same time?"[25] And Lydgate enjoys flirting with Rosamond, who was as "sweet to look at as a half-opened blush-rose, and adorned with accomplishments for the refined amusement of man."[26] Lydgate has no intentions of marrying Rosamond; he sees his relationship with her as harmless fun, unaware that Rosamond has other plans for him. He sees Rosamond only as a charming creature, beautiful, ornamental, and amusing, but not as a person with her own will. Although Rosamond is a superficial person who is mostly concerned with maintaining her comfortable lifestyle, Lydgate fails to detect her plans because he fails to see her as a person with her own ambitions and vision of her future. He has only a superficial understanding of their relationship, resulting in the lack of thought towards its possible implications. However, Lydgate and Rosamond do

[25] Ibid., 185.
[26] Ibid., 186.

marry, with Lydgate's proposal bursting forth from a combination of societal pressures and gossip, Rosamond's tears, and his own rashness.

Unfortunately, their marriage is not a happy one. Since Lydgate remains preoccupied with appearances and Rosamond is accustomed to an expensive lifestyle, they live beyond their modest means and are soon in debt. And Lydgate's and Rosamond's initial impressions of each other soon sour. They soon realize they knew very little of the other's true self and find these new revelations into their partner's characters unpleasant. Lydgate realizes

> how far he had travelled from his old dreamland, in which Rosamond Vincy appeared to be that perfect piece of womanhood who would reverence her husband's mind after the fashion of an accomplished mermaid. . .
>
> There was gathering within him an amazed sense of his powerlessness over Rosamond. His superior knowledge and mental force, instead of being, as he had imagined, a shrine to consult on all occasions, was simply set aside on every practical question. He had regarded Rosamond's cleverness as precisely of the receptive kind which became a woman. He was now beginning to find out what that cleverness was—what was the shape into which it had run as into a close network aloof and independent.[27]

Lydgate comes to see that despite Rosamond's quiet and feminine exterior, she sets to use her conditions and options in her favor, regardless of what that may entail for others. During their whirlwind courtship, Lydgate was completely oblivious to this side of Rosamond, seeing her instead as a pretty ornament who lives to please her husband. It never occurs to him that she may have her own plans, which might impede his. Although Lydgate makes some gains in establishing his medical practice, his efforts to keep Rosamond happy and maintain their expensive lifestyle prevent him from working on his

[27] Ibid., 404.

scientific ambitions. The debt they accumulate and the pressures of the collector drive them further apart and further into desperation.

Eventually Lydgate turns to Mr. Bulstrode, a wealthy Middlemarch banker, who lends Lydgate the money, but also embroils him in a scandal. Lydgate feels as though his world is crashing down around his head: "Everything that had happened to him there seemed a mere preparation for this hateful fatality, which had come as a blight on his honourable ambition. . . Lydgate thought of himself as the sufferer, and of others as the agents who had injured his lot. He had meant everything to turn out differently; and others had thrust themselves into his life and thwarted his purpose."[28] Lydgate realizes how far his life is from his original dreams, but he attributes his failures to the others who intruded upon his life. Although those in his life certainly tempted his ambitions away from their intended path, Lydgate's "spots of commonness" prevent him from placing the burden of blame on himself. He still does not see fault in his decisions and actions, but his troubles as caused by others.

Although Lydgate may not fault himself for his present circumstances, he sadly accepts them. Lydgate and Rosamond are soon redeemed, but "[p]oor Rosamond's vagrant fancy had come back terribly scourged—meek enough to nestle under the old despised shelter. And the shelter was still there: Lydgate had accepted his narrowed lot with sad resignation. He had chosen this fragile creature, and had taken the burthen of her life upon his arms. He must walk as he could, carrying that burthen pitifully."[29] A little older, a little wiser, Lydgate realizes that despite how he came to his present situation, he

[28] Ibid., 509.
[29] Ibid., 552.

must accept it. He chose Rosamond and accepts that a life with her is not compatible with a life of furthering science. He gives up his ambitions in order to fulfill his duty towards Rosamond. Soon after the scandal, Lydgate and Rosamond quit Middlemarch and Lydgate builds a successful practice treating wealthy patients. To all outsiders, Lydgate appears to be a successful physician with a charming wife. However, Lydgate "always regarded himself as a failure: he had not done what he once meant to do."[30] Despite his best intentions, Lydgate's blindness in the nonscientific spheres of his life eventually came to dictate how his life would unfold, crowding out the lifestyle needed for scientific contemplation.

Lydgate's spots of commonness that drew his attention to women and furniture eventually dictated the shape of his life because he did not put together how his scientific ambitions related to his nonscientific desires. His vanities and material habits put him on a path that took him away from pursuing science, without his even realizing his redirection until it was far too late. However, his blindness to the various obstacles in his life that thwarted his scientific ambitions is not particular to being a scientist, but is applicable to a person's character and pursuit of a life well-lived in general. The capacity to see the obstacles that can impede the fruition of future plans is important for everybody, regardless of their specific ambitions. True to her stated purpose, in Lydgate, Eliot shows how seemingly unrelated concerns (science and furniture) are actually very much related, where his desires, ambitions, and weaknesses are part of how he developed his character, and subsequently, the shape of his life. Using Lydgate as a cautionary figure, the real-world

[30] Ibid., 575.

scientist may come to understand that part of being a good scientist includes arranging one's life in such a way that allows the pursuit of scientific knowledge. Lydgate's inability to see his obstacles because he thought they had no bearing on his scientific life speaks to the importance of not drawing boundaries that separate the various facets of one's life, but instead considering how they hinge upon each other. A person's character as a scientist should not be understood separately from his character as a person. Lydgate can serve as cautionary figure for the need to pay attention to the interconnectedness of a life and how decisions in one area can have significant repercussions for another.

Eliot's Lydgate is not only one of the first serious treatments of a physician in literature that realistically paints medicine at the time, but it is also a nuanced tracing of how the frames of mind one adopts and the seemingly frivolous decisions (for Lydgate, flirting and furniture) one makes can turn out to have great import on the shape of one's life. Lydgate's inability to recognize his faults and realize how they can stand as deterrents to his ambitions eventually derails his plans of great work for the world. Indeed, Lydgate does not even recognize his failings as failings; he sees them simply as his way of functioning within the world. Thus, he is blind when it comes to understanding these failings as obstacles to his ambitions. While Lydgate is a capable physician, he is less discerning when it comes to women, rashly falling in love without much thought towards compatibility. Initially regarding his relationship with Rosamond as an amusing dalliance, he soon finds himself married much earlier than he intended, to someone who turns out to be much more willful and selfish than he ever imagined. Starting with his flirtations with Rosamond, Lydgate unknowingly entangles himself in a web from which he never escapes.

Eliot carefully traces how his small, seemingly harmless actions and character traits snowball into a mountain of debt and a humiliating scandal. And at the end of his life, Lydgate ostensibly appears to have led a successful life, but Eliot makes it clear that Lydgate is a failure because he abandoned his scientific ambitions by taking the path that fed his vanities instead of his dreams. Although Lydgate knows what kind of practitioner he intended to be, he lacks the insight needed for seeing what traits and values he needs for becoming a scientist or what kind of woman he should pursue who would support, or at least not thwart, his scientific ambitions. Lydgate stands as an example of how lack of reflection upon one's own character, motives, and intentions can result in thwarted dreams.

Moral Slippage and Scientific Misconduct

In a twentieth century depiction of the ordinary scientist in literature, Allegra Goodman examines the pressures, personalities, and habits of mind that can eventuate in suspected ethical transgressions in scientific research. Like Eliot, she is interested in examining human nature through her characters' decisions and actions once events are set in motion. Although Goodman does not explore the webs of relationships that entangle seemingly separate lives, like Eliot, she is interested "in painting her characters and in moving them around on a vast canvas" to elucidate human nature and to see what consequences precipitate from her characters' decisions and actions.[31] Goodman seeks to explore the "character and motives and ambiguity" that are intertwined with scientific

[31] Susan Longhito, "No Lab Is an Island: A Review of *Intuition*," *FASEB Journal* 21, no. 10 (August 2007): 2272.

research.[32] Taking their characters as her starting point, Goodman explores moral ambiguity in the lab setting and the ways the researchers navigate through them. Through establishing their personalities and habits of mind and manipulating their circumstances, Goodman shows how these all interact in contemporary biomedical research to first propel the lab into the public eye and then to cause their fall from grace.

Set in the fictional Philpott Institute, *Intuition* follows the inner workings and dynamics of a cancer lab headed by Marion Mendelssohn and Sandy Glass.[33] Loud and ambitious, Sandy works mainly as an oncologist and is characterized by "a quality that went much farther than youth or beauty—an irresistible liveliness that seemed to override cynicism and doubt, a self-confidence occasionally unbearable, but in many cases deeply reassuring. . . Sandy's sparkling savoir faire made him a stellar oncologist. He radiated hope to every patient. . . He wasn't going to give up on them and turn spiritual. He was an old-fashioned doctor, fighting tooth and nail against disease."[34] He exudes confidence in everything he does, projecting that image onto the lab as its public face. Sandy is a researcher who dreams big ideas and knows how to craft his science to appeal to the funding agencies and the public. In contrast, Marion is a rigorous and exacting researcher, accepting only science that meets her high standards: "[a]fter years of ceaseless competition, she'd grown thin and patient, critical of herself and others. Anyone who worked for Marion tensed at her glance and dreaded her questions—never rhetorical, never dramatic,

[32] Gina Kolata, "Writer Depicts Scientists Risking Glory for Truth and Truth for Glory," *New York Times*, March 21, 2006, accessed September 7, 2012, Available at http://www.nytimes.com/2006/03/21/science/21prof.html#.

[33] Although the Philpott Institute is fictional, it is modeled on the Whitehead Institute, where Goodman shadowed some researchers.

[34] Allegra Goodman, *Intuition* (New York, NY: Dial Press Trade, 2006), 18.

but quietly devastating in their acuity. With one pointed query she could lift the paint off the best ideas to reveal the rotting suppositions beneath."[35] She is the scientific force of the lab. Although lacking in Sandy's ability to charm the funding agencies, she is the one who critically examines the data to see if they are sound or not. Together, the two complement each other, relying upon each other's distinct skills to keep the lab running. The pairing of Marion and Sandy highlights the various pressures in modern science and the skills needed. Scientists face pressures to produce scientifically sound data, to compete among other scientists for funds, prestige, and accolades, and to shape their research in a way that appeals to the funding agencies.

Various technicians and postdoctoral fellows populate the lab, forming something of a little family and sharing in each other's trials and jokes that comprise daily laboratory life. One of the postdocs, Cliff, stumbles across a promising cancer treatment after doggedly working on his project for several years, even after Marion and Sandy tell him to stop. Suddenly, after so long without fundable results and their available funds quickly dwindling, the lab is thrown into a state of tense excitement and optimism, particularly Cliff, who works unceasingly to get the results past the preliminary stage, even if that means skirting some established lab procedures. Cliff works as if in a haze, pinning his hopes on these results, feeling "the propulsive energy of scientific questions, the relentless force of an investigation that might succeed. . . It seemed to him now all his previous work had given him nothing, and that he, in his thirty years, had given nothing to the world. This was his chance now, and with it came a weight of hope and expectation that he could

[35] Ibid., 21.

hardly bear."[36] Sandy is overjoyed and pushes hard to announce the results even though they are not complete and have not yet been verified by other labs. Sandy urges Marion to release the results, even if they may be premature. The prestige and funds the publicity would bring to the lab would benefit them all immensely. Although Marion initially resists Sandy, she becomes swept up in Cliff's results and allows the results to be publicized to scientific and lay audiences.

Another postdoc, Robin, disgruntled and hurt by Cliff's newfound success and the channeling of the lab's attention and resources to his project, begins to look into his notes and raw data. In her search, she finds some omitted data that she cannot reconcile with the published results, bringing it to everybody's attention. As the novel unfolds, her suspicions result in a Congressional hearing and the dissolution of Sandy's and Marion's partnership. Although the lab is eventually acquitted of scientific wrongdoing (after first being convicted), Goodman sets up this high-pressure environment for scientific research—the ceaseless need for funding, the competition within and between labs, the years of drudgery that may or may not result in anything fruitful, the obsessive quality that can take over the researcher when pursuing promising results, as well as the researchers' own human flaws and weaknesses, their "spots of commonness"—all as relevant factors as she maps the lab's rise, fall, and recovery. Although accusations of scientific misconduct are raised, they are never quite resolved. But that is not Goodman's purpose; instead of providing a definite answer, Goodman is more interested in tracing the subtle moral slippage that can occur when these various factors collide.

[36] Ibid., 52-53.

The novel's scientists are carefully created as realistic people who have their own cares and desires, and are on the whole, ordinary people encountered in daily life. Goodman shows how the various pressures and vanities subtly override the characters' capacity to think clearly about how they interpret and present their work. Although Marion cannot see how Sandy has changed her, her husband, Jacob, senses how that collaboration has eroded her scientific integrity, which becomes magnified with Cliff's results: "There was something wrong with Marion. Of course Jacob saw it at once. She worked as hard as always, did just as much, but she tore through her days with reckless speed. . . She'd been infected by Sandy's hype."[37] She is swept up in Sandy's enthusiasm, overriding her characteristic caution and skepticism. Partly because she lets her guard down, the lab is embroiled in the accusations of scientific misconduct. Arguably, if she had insisted on gathering more data and verified their results or prohibited premature publication, she could have caught the inconsistencies that later appeared and avoided the public scandal. However, with the lab's funding woes and their long dearth of promising results, Cliff's data are much needed, and Marion's inability to resist Sandy's enthusiasm in this matter is understandable. While her lapse in judgment may not be excusable, it is understandable in her situation. By the end of the novel, Marion regains her moral compass, concluding they had published too quickly, without enough evidence. She tells Sandy, "I've gone over everything in my mind—and I think Cliff's results were rushed, and that our conclusions were aggressive. We published too soon; there wasn't enough there.

[37] Ibid., 154.

His findings were too thin to support such an ambitious research program."[38] She eventually admits to herself that she allowed herself to get carried away by the potential of the data, instead of what the data tell her.

After she admits this to herself, she calls Cliff to explain the inconsistencies in his data, why neither of the external labs can reproduce his results. Cliff believes he has not done anything wrong. When she asks why the omitted data wasn't published, he tells Marion he published "[e]very single scrap of relevant data."[39] In that, Marion catches his equivocation without his awareness that he was equivocating. Cliff thinks he did solid scientific work, but

> [p]erhaps his work with R-7 had been more about ideas than concrete facts; perhaps his findings had been intuitive rather than entirely empirical. He had not followed every rule. . . He had not dissected every animal. He had not chosen to discuss every piece of data, but had run ahead with the smaller set of startling results he'd found. Still, aspects of his data were so compelling that in his mind they outweighed everything else. He had sifted out what was significant, and the rest had floated off like chaff.[40]

He dedicated himself so wholly to his project that he could not see how that dedication blinded him to his own bias. He saw the tumors shrinking on the mice and that was enough to convince him of his treatment's efficacy. He did not see how this gave him a type of tunnel vision, how he paid attention only to the results that conformed to his expectations, while setting aside the ones that didn't and failing to return to them. He did not do this maliciously, consciously manipulating his data to show these startling results, but as he teetered on the edge of potentially discovering something huge, he winnowed out

[38] Ibid., 351-352.
[39] Ibid., 358.
[40] Ibid., 359.

the contradictory data without even realizing he was doing it. Similar to the way that Lydgate's spots of commonness blind him to seeing how his lifestyle choices could thwart his scientific ambitions, Cliff is unable to see how his scientific drive and ambitions filter how he interprets his data and how he considers what data are relevant.

Goodman maps the subtle transgressions her characters commit without their awareness of what they are doing. No one deliberately withholds or fabricates data, but it happens regardless because, in their collective zeal, they lose sight of doing careful, solid scientific work. Goodman takes care to portray the various scientists' characters as ordinary and recognizable. The pressures of modern science and Cliff's data as a potential way out, combined with their own vanities and weaknesses, culminate in the relaxing of their judgment and their inability to see the problems with the data at the beginning. Their transgressions are human ones, and their story can be seen as one of ordinary weaknesses that were unfortunately thrust into the public spotlight. However, although their story may be one of extraordinary circumstances that spiraled beyond anyone's control, the ethical oversights and moral slippage they suffer are ones to which all people are vulnerable.

Although Marion and Cliff must eventually come to terms with their moral erosion, other scientist characters can serve as figures that more closely resemble the virtuous scientist. The postdoc Robin, who brings forth Cliff's inconsistencies, faces significant obstacles after accusing Cliff. Shortly after she makes her accusations, she leaves the lab but manages to cobble together some work. She feels isolated and abandoned, but despite that, she continues to advocate for her case of scientific misconduct because she believes her cause has value, not only in redeeming herself but also in helping others. She hopes that her actions might have "some value in saving time for other scientists who tried to reproduce Cliff's results. . . She could not be angry and alone forever. She would not let Marion write her off as incompetent."[41] In deciding to formally pursue her case against Cliff, she believes her cause has value, both to herself and the scientific community. However, it soon spirals beyond her control, ballooning into proportions beyond anything she imagined. She feels that "her questions were not hers anymore; her doubts had grown into weather systems of their own, her single intuition now transformed into a conspiracy theory implicating not only Cliff but nearly everyone who worked around him. . . Robin felt as if she'd stepped through the looking glass into another world, where lawyers and politicians were the true investigators and scientists the pawns."[42] She is swept along by the tide that she created.

And Robin tries to navigate her way through this tide, searching for a way to continue doing science with her values intact. Although she sets in motion a chain of events over which she loses control, of all the scientists, Robin most resembles a virtuous scientist who tries to practice sound, ethical science. She continues to fight for her case against Cliff because she believes that what she is doing is in the name of good science. But while her actions are admirable, her motivations are not perfect. While she does bring forth her concerns for the good of science, her initial investigations into Cliff's data were in part prompted by jealousy and anger, both professional and personal. Like all the other scientists in the novel, Robin is a flawed, fallible person. She has both admirable and petty motivations. But by the end, she draws from the admirable motivations in pushing for her

[41] Ibid., 248.
[42] Ibid., 281-282.

claims, believing suspect science should be brought forth despite the fall out. She continues to push for her concerns because something felt wrong with his data and ignoring that hunch contradicted her idea of science practiced well, despite the isolation and animosity others feel towards her. Although Robin is flawed, she also exercises virtue in advocating for a widely held conception of a good science, that of a scientifically sound, honest science, because she feels it is the right thing to do.

If scientists are thought of as ordinary, fallible people, then the transgressions of the scientists in the novel could be considered applicable to real-world scientists. The vast majority of these kinds of ethical transgressions, the filters used in deciding what is relevant, the gradual changes in habit and perspective in response to shifting pressures and circumstances, do not typically culminate in Congressional hearings.[43] And they do not occur only in such high profile areas of research, but as all of science is very much a human enterprise, this slippage likely occurs across the wide range of research. But for the most part, they occur undetected, likely without the scientist's realization that her scientific integrity is slowly eroding away. With this in mind, Goodman's novel can be read as a type of cautionary tale, a call to remain vigilant to these kinds of moral lapses. While undoubtedly scientists and lay people alike should be alert to all types of ethical transgressions, large and small, it is the small ones that more easily slip under the radar and

[43] Some reviewers have noted the resemblances between the accusations and events in *Intuition* and in what has come to be called the Baltimore case, which culminated in Congressional hearings. In the Baltimore case, a postdoc, Margot O'Toole, accused a researcher, Thereza Imanishi-Kari, of scientific fraud. The events of the Baltimore case have been chronicled by Daniel J. Kevles in *The Baltimore Case: A Trial of Politics, Science, and Character* (New York, NY: W. W. Norton, 1998). While Goodman is familiar with Kevels' book, her purpose in *Intuition* is not to provide a rehashed account of those events. From Kolata, "Writer Depicts Scientists Risking Glory for Truth and Truth for Glory."

get lost in the shuffle of daily life. By using the novel as a space to reevaluate the state of their own moral compass and becoming aware of their possible occurrence, both scientists and lay people are better equipped to guard against this moral erosion. However, Goodman creates a character, who may not be a shining exemplar of moral virtue, but tries to do what she feels is right, for the right reasons. By having Robin bring forth the inconsistencies in Cliff's data, she advocates for a science that is practiced well, of doing science in a way that enables it to generate scientifically sound knowledge, and continues to push for this vision of science despite the resistance. The reader can view Robin as an example of an ordinary, flawed scientist trying to exercise virtue in a difficult situation and can be held in comparison to the moral erosion that Cliff and Marion suffer. Reading Robin as an admirable character can illustrate to the reader how difficult virtue can be at times, but also why someone would choose that path, despite the difficulties.

Conclusion

Historical and literary explorations of the scientist can serve as valuable resources when understanding the scientist's character as a critical factor in the shape and development of the scientific enterprise. The historical and literary works discussed here focus on various features of how the scientist's character shapes science. The historical discussions focus on the image of the scientist's character within the scientific community and how that image has shifted over time, with different traits emphasized for different purposes. It emphasizes the importance of the scientist's character in science's development, for drawing science's boundaries, helping define its methods, and representing scientific practice to the public. In contrast, the literary works focus on the frames of mind of the scientists, and how those can play a significant, but unacknowledged, role in the scientists' motivations, decisions, and actions. Both *Middlemarch* and *Intuition* realistically trace how unacknowledged habits, dispositions, and biases greatly affect how one practices science. They tease apart the many factors that resulted in the undoing of Lydgate and Cliff, demonstrating how the lack of reflection upon those habits and dispositions of mind can have unwanted effects. Both the historical and literary works usefully bring the scientist together with the various pressures she (either as an individual or as part of the scientific community) faces, showing how the scientist's character is critical to her response.[44]

When thinking of the scientist as an ordinary person, instead of an exaggerated caricature, the real-world scientist can begin to see how her character matters a great deal in scientific practice. It serves as a filter through which others perceive her and her work, and also filters the way she understands and interprets her own work. The way she approaches and practices her work, the way she presents herself, the seemingly small and unrelated decisions she makes as her life and research unfold, all reflect different facets of her character. Doing science well appears to depend not only on being technically proficient, but also on the kind of character the scientist demonstrates through her decisions and actions. Turning to history and literature can help the real-world scientist better understand and navigate that part of science. Literature and history show how the

[44] Notably, the literary examples of the ordinary scientist focus on the stumbling blocks in the scientist's character that can impede the production of good scientific knowledge. Admittedly this is a fairly one-dimensional characterization of how the scientist's habits of mind shape how she practices science. Stories could be written about how a scientist's habit of mind led her to produce knowledge that is scientifically solid and socially reflective or how her habits of mind enabled her to overcome obstacles to producing that type of knowledge. However, those stories are hard to come by.

scientist's character is a central feature in scientific practice, that the work cannot be separated from the person. Through revealing how a person's character directs what options she sees before her or how she arranges her priorities, the literary and historical accounts of scientific character can help the real-world scientist reflect upon her own perspectives for how she approaches and interprets her work. They help the real-world scientist imagine the possible consequences of ignoring their influences. This awareness better equips the real-world scientist to be watchful for and to identify the moral erosion that may occur in herself and in others.

Chapter 5: The Mad Scientist

At first glance, the figures of the mad and heroic scientists may seem at odds with cultivating *phronêsis*. Unlike the carefully crafted renderings of Lydgate and the scientists in *Intuition,* depictions of mad scientists are caricatures of scientists, grossly exaggerated with unrealistic personalities, making them seem irrelevant to the real-world scientist. These caricatures stand in stark contrast with the attention to detail and care for nuance required of the moral agent's development of *phronêsis*. If *phronêsis* calls for attending to a situation's subtleties and imagining the distinct perspectives of those involved, then the figures of the mad scientist and the heroic scientist appear to contradict the requirements of *phronêsis* by providing a very one-sided and unrealistic image of the scientist. However, despite the seeming contradictions, the real-world scientist can benefit from reflecting upon these unrealistic caricatures. They can serve as proxies for discussing the many apprehensions and hopes the public has about science, which can help the scientist better understand a situation's moral landscape. Having a grasp of the public's views of science and the scientist can help the real-world scientist when working through the multitude of perspectives, by clarifying what might inform some facets of other perspectives.

Understanding these figures and why they persist in the public imagination further cultivates the scientist's *phronêsis* by exploring the fears and hopes that these figures represent. While the figures of the mad or heroic scientists, their situations, and their responses can seem outrageous when viewed within the context of the issues they represent, the real-world scientist can begin to pick out what responsible and ethically sound research might look like. She can use these figures as a beginning point for seeing the fears that surround science and what type of science she should not practice and why. Additionally, the mad scientist and the heroic scientist serve as touchstones that encapsulate some of the moral features associated with those figures and can provide beginning points for exploring those moral issues. Although the figures of the mad and heroic scientist themselves are one-dimensional, when examined for what moral issues they encapsulate, they provide a multidimensional understanding of scientific practice that brings some of science's moral implications to the forefront. They help the real-world scientist cultivate *phronêsis* by creating a space for the scientist to engage in thoughtful reflection upon the moral issues. Since the figures reflect the public's fears about and hopes for science, they also provide the real-world scientist a way to explore the larger context within which her work operates. Although the characters themselves might be unrealistic, they represent the very real fears and hopes that inform the public's view of science. The mad and heroic scientists help the real-world scientist attend to the wider context of her research, which must necessarily be taken into account when pursuing a *telos* that aims for responsible and ethical practice of science.

For examining mad and heroic scientists, history and literature can be used in conjunction. The figures of the mad and heroic scientists are steeped both in fact and in fiction, Victor Frankenstein with Josef Mengele, Martin Arrowsmith with Walter Reed, blend together to form images of science and the scientist. Arguably, the historical figures are distorted because of their association with the fictional characters. Instead they should be construed as neither monsters nor heroes, but as ordinary people responding to the social and cultural climate of their time. However, the figures' association with people who once actually lived and breathed is precisely why the real-world scientist can benefit from reflecting upon heroic and mad scientists. The boundaries separating fiction and reality blur when imagining mad and heroic scientists. It is because those fictional characters hold the potential to become manifested in actual scientists, or at least can seem similar enough to actual scientists, that make those characters relevant to the real-world scientist. The fictional character holds the possibility for the real-world scientist to be interpreted as a mad or heroic caricature. Through understanding why these caricatures have the potential to become actual, the real-world scientist can explore the reasons, the choices, and the circumstances that resulted in that character's casting as a caricature. The issues encapsulated by these figures are often issues that real scientists have to face, either directly themselves or tangentially as a member of the scientific community. In some ways, the figures of the mad and the heroic scientist blur the line between pure fiction and reality, with the figures just real enough to raise legitimate questions about crafting an ethical and responsible scientific practice, the appropriate boundaries of scientific inquiry, and what responsibilities the scientist has to society.

The real-world scientist can cultivate *phronêsis* through examining and reflecting upon these figures because they create space for deliberating about those questions, which are applicable to actual science. Although the figures of mad and heroic scientists may not provide the careful and nuanced view of the scientist that *phronêsis* requires, when used in conjunction with each other and with the ordinary scientist, they give the scientist additional perspectives by raising questions about what makes science ethical and responsible and about science's boundaries. These figures can serve as catalysts for deliberating science's moral implications, hopefully preventing the caricatures and their transgressions from becoming actual.

In this chapter, I will focus on the figure of the mad scientist, discussing the various features of the mad scientist, the mad scientists' relationship to the practice of science, and the apprehensions the mad scientist encapsulates. As most historical works portray science and scientists as an ordinary, human practice, I have selected works of fiction in which the author clearly intends to present the scientist as mad, but include historical discussions to supplement the exploration of the literary works. I will examine how that figure can be used as a beginning point to explore the very real moral issues entangled with a mad practice of science and how the real-world scientist can use the mad scientist in cultivating her *phronêsis*.

Fearsome Science: The Figure of the Mad Scientist

The present figure of the mad scientist embodies a variety of characteristics that propel his madness.[1] Allen E. Hye enumerates four prime traits of the scientific man: 1) A desire to *accumulate* ordered facts; 2) A desire to *examine* this knowledge critically in order to understand more about the human condition; 3) A desire to *control* nature, placing knowledge and understanding in the service of technology; and 4) A desire to *possess*

[1] Overwhelmingly, representations of both mad and heroic scientists were, and still are, male. As science was emerging as a fledgling discipline, the vast majority of its practitioners were male. Additionally, the rigors of science were thought to be unsuitable for feminine minds. Although the numbers of women scientists have increased markedly over the last half of the twentieth century, the modern scientist is still typically represented as male. For additional reading about science as a particularly masculine practice and some of the issues that entails, *Feminism and Science*, ed. Evelyn Fox Keller and Helen E. Longino (Oxford, UK: Oxford University Press, 1996), a collection of essays whose references include other readings that critique science from a feminist perspective, is a good place to start.

knowledge with absolute *certainty*.[2] Although the scientist may not embody all these traits, he possesses most of them or at least identifies with them. The scientist desires to accumulate knowledge and examine this newfound knowledge. With this knowledge, he desires to control or manipulate nature, particularly through technological means. He hopes the knowledge provides him with irrefutable, universal truth about nature, a basic truth of life. For the mad scientist, these prime traits become exaggerated and taken to extreme lengths, although they differ in their exaggerations among various mad scientists. Kristine Larsen delineates five characteristics of the mad scientist, namely that the mad scientist disregards ethical considerations, which encompasses having an immoral intent, employing an immoral methodology, having an immoral result, and conducting his research in secret.[3] Although any one mad scientist may not express all of these characteristics, each one embodies some of them. For most mad scientists, the desires and goals of the ordinary scientist morph into obsessions; the pursuit of knowledge and control of nature come to dominate all other areas of his life despite the consequences for himself, his loved ones, or society. Often this obsessive pursuit oversteps the boundaries of appropriate knowledge of the world, using inappropriate means. For mad scientists, there is no limit to what humans should know or do, despite the costs.

Another characteristic common to many mad scientists is their secrecy about their work. Their pursuit of knowledge is a solitary endeavor that takes place in a mysterious, shadowy laboratory. Having eschewed his familial and societal ties, the mad scientist

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[2] Allen E. Hye, *The Moral Dilemma of the Scientist in Modern Drama: The Inmost Force*, vol. 38, Symposium Series (Lewiston, NY: Edwin Mellen Press, 1996), 6-7.

[3] Kristine Larsen, "Frankenstein's Legacy: The Mad Scientist Remade," in *Vader, Voldemort and Other Villains: Essays on Evil in Popular Media*, ed. Jamey Heit (Jefferson, NC: McFarland, 2011), 47-48.

works alone, with only his thoughts and equipment for company. Often his work is done in secret, with his family and friends deliberately left unaware of his lines of inquiry. His work is mysterious, often "depicted ambiguously, illogically, and mysteriously, in other words, irrationally. Thus are the experiments, the laboratories, the drugs, the rays, and the forces that are handled by mad scientists. The physical artifacts of their science are presented as the miscellaneous material junk of alchemists, illogically connected and barely justified."[4] Although the mad scientist is supposedly doing science, the reader has only a hazy idea about the details of his work; it seems closer to magic than science. These mad scientists work in spaces that the author only briefly discusses or are described in enough gory detail to highlight their unpleasantness. In contrast to literature that valorizes and glorifies science, the mad scientist's workspace is shrouded in mystery, unknowable to his friends, family, and the reader.[5]

Though the mad scientist represents an irresponsible, unreflective science, what makes him mad can take on a variety of forms. The mad scientist sometimes pursues knowledge for its own sake, out of curiosity, but other variations present the mad scientist pursuing knowledge for personal gain, such as wealth or fame or power. Sometimes the mad scientist is a power-hungry individual, out to destroy the world, but at other times, he is an inexperienced novice, dabbling with forces beyond his comprehension or control. Some mad scientists are depraved, thus producing knowledge that is also depraved.

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[4] Christopher P. Toumey, "The Moral Character of Mad Scientists: A Cultural Critique of Science," *Science, Technology, & Human Values* 17, no. 4 (Autumn, 1992): 414.

[5] In science-fiction literature that celebrates science, the physical artifacts of science and technology are often proudly displayed. They are presented as clean, shiny, and new and are often discussed in loving detail.

However, others seek knowledge that is inherently evil and has a corrupting influence.[6] The type of science he does varies, as do his motivations and intentions. Sometimes the mad scientist's work seems to use magical means for dominating nature, while other mad scientists use technological or mechanical means. Some mad scientists are coldly detached from their work, trying to maintain objective distance, while others cannot keep their passions at bay and are excited and inflamed by science's potentials. Mad scientists have been cast as sorcerers, tyrants, monsters, and spies.[7] However, they all embody an obsessive, all-consuming science that possesses them to pursue it, despite the consequences. Through their investigations, they overstep their boundaries, searching for knowledge beyond the range of appropriate human capabilities without the prudence and caution necessary for good judgment.

Creating a Monster: Frankenstein as the Mad Scientist

Perhaps more iconic than any other figure of the mad scientist is Dr. Victor Frankenstein, who serves as the prototype of a scientist so caught up in his work that he fails to consider its consequences, resulting in a tragic cycle of destruction for himself and his creation. Created by eighteen-year-old Mary Shelley in 1816, *Frankenstein; or, The Modern Prometheus* originated as her submission into a ghost story competition amongst friends and her husband as a way to pass time during a rainy summer on Lake Geneva. Shelly sought to create a story that "would speak to the mysterious fears of our nature, and

[6] Toumey, "The Moral Character of Mad Scientists," 415.

[7] Spencer Weart, "The Physicist as Mad Scientist," *Bulletin of Science, Technology, & Society* 8, no. 2 (April 1988): 143-148, 50-52.

awaken thrilling horror."[8] She found this in a flash of inspiration one night when her imagination presented an image of

> the pale student of unhallowed arts kneeling beside the thing he had put together. I saw the hideous phantasm of a man stretched out, and then, on the working of some powerful engine, show signs of life and stir with an uneasy, half vital motion. . . His success would terrify the artist; he would rush away from his odious handywork, horror-stricken. He would hope that, left to itself, the slight spark of life which he had communicated would fade; that this thing, which had received such imperfect animation, would subside into dead matter; and he might sleep in the belief that the silence of the grave would quench for ever the transient existence of the hideous corpse which he had looked upon as the cradle of life.[9]

Shelley formed her story around this scene, the first moment of the Creature's life and the creator's reaction of horror and rejection. Unfortunately for the creator, Dr. Victor Frankenstein, the Creature does not subside into dead matter, but continues to persist, learning to speak, learning about humankind, yearning for companionship, and coming to search for his creator.

In his love affair with science and quest to find the cause of life, Frankenstein comes to embody the obsessed scientific genius who relentlessly pursues knowledge and power, devoting all his time and attention to his scientific pursuits. When Frankenstein does discover the cause of life, he sets out to create a being in the likeness of man from dead matter. At the outset, he hesitates slightly in carrying out this plan, "doubt[ing] at first whether [he] should attempt the creation of a being like [himself] or one of simpler organization; but [his] imagination was too much exalted by [his] first success to permit [him] to doubt of [his] ability to give life to an animal as complex and wonderful as

[8] Mary Shelley, author's introduction to "Frankenstein; or, the Modern Prometheus," in *The Norton Anthology of English Literature*, ed. M. H. Abrams and Stephen Greenblatt, Norton Critical Edition, (New York, NY: W.W. Norton, 2000), 910.

[9] Ibid., 911.

man."[10] His hesitation seems to stem from the extraordinary technical obstacles he faces, rather than from the ethical and moral consequences of his work. Regardless, the hesitation is quickly swept aside in his excitement to push the boundaries of his work. Frankenstein labors at his Creature until his "cheek had grown pale with study, and [his] person had become emaciated with confinement. Sometimes, on the very brink of certainty, [he] failed; yet still [he] clung to the hope which the next day or the next hour might realize. . . a resistless, and almost frantic impulse, urged [him] forward; [he] seemed to have lost all soul or sensation but for this one pursuit."[11] Frankenstein neglects his family and friends and becomes increasingly isolated as his world narrows to encompass only his fevered investigations. His obsession and his isolation become trademarks of the mad scientist figure. They cause him to lose himself in his work in a destructive way. He neglects the bonds that tie him to family, friends, and society, which causes him to lose sight of the responsibilities and obligations they entail. With scientific obsession as his driving force, Shelley does not cast Frankenstein as someone with evil intentions. He does not undertake his investigations intending to possess or destroy anyone; he does not mean anyone any harm. Frankenstein's failing, then, is that he allows his obsession to take over his life neglecting to give any consideration to what might come once the creature is complete. He does not consider the creature's future or its potential to be its own being, his possible feelings towards it, or the implications his investigations may hold for society.

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[10] ———, "Frankenstein; or, the Modern Prometheus," in *The Norton Anthology of English Literature*, ed. M. H. Abrams and Stephen Greenblatt (New York, NY: W.W. Norton, 2000), 932.

[11] Ibid., 933.

Subsequently, Frankenstein is ill-prepared to confront his own horror once the Creature awakens, and he reacts very badly. In the two years preceding the moment of the Creature's animation, Frankenstein exhausts himself mentally and physically in his pursuit of animating the lifeless matter. He "had desired it with an ardour that far exceeded moderation; but now that [he] had finished, the beauty of the dream vanished, and breathless horror and disgust filled [his] heart. Unable to endure the aspect of the being [he] had created, [he] rushed out of the room, and continued a long time traversing [his] bed-chamber, unable to compose [his] mind to sleep."[12] Eventually, Frankenstein does sleep, but his rest is plagued by nightmares. He starts awake to find the Creature in his room, looking at him. Frankenstein flees his house for the remainder of the night and part of the next day. Upon his return, the Creature has vanished, much to Frankenstein's relief. And although Frankenstein thinks of the Creature often in the ensuing months and years, he makes no effort to find the Creature or what happened to it, despite several tragedies that befall his family that Frankenstein knows were perpetrated by the Creature. It is not until the Creature finds Frankenstein that Frankenstein learns of the Creature's whereabouts and together they begin on their path of mutual destruction.

Thus Frankenstein's first failing leads to his second. His lack of reflection upon anything past the Creature's moment of awakening causes him to respond in horror at his creation and run away. Had he paused to think about his work and its consequences, and his reactions towards it, he might have abandoned his work or made some sort of plan for the Creature's future. Frankenstein is not inherently evil and does not intend to use his

[12] Ibid., 935.

knowledge to corrupt humanity, but acts more like the sorcerer's apprentice. He pursues and harnesses forces that he is ill-equipped to control and they soon overwhelm him. However, Frankenstein is no one's apprentice and does not have an older, wiser teacher who can subdue the forces he has set in motion. Instead of attempting to clean up his mess, Frankenstein refuses to face it and runs away, leaving the mess unresolved. Frankenstein's lack of responsibility towards the Creature is another hallmark of the mad scientist, the loosening of a product of science upon an unsuspecting public without regard for its welfare, in this case either the welfare of the Creature or the public. Indeed, the story's subtitle, *The Modern Prometheus*, references the Prometheus story in Greek mythology. In this myth, Prometheus, a god and champion of mankind, steals fire from the other gods and gives it to man. Fire was held to be used exclusively by the gods, not humankind's benefit. As punishment for this trespass and a few others, Zeus condemns him to be chained to a great rock and to have his liver eaten by a great eagle, only to have his liver regenerate and be eaten again every day. In this myth, Prometheus oversteps his boundaries and suffers much misery because of it.[13] Similar to Prometheus, Frankenstein crosses into realms of knowledge that are dangerous for humanity, only to cause his downfall. Frankenstein has come to symbolize a science that has surpassed acceptable boundaries and a shortsighted, irresponsible scientist.

Although the Creature is now typically depicted as an ungainly, monstrous brute, Shelley originally presents the Creature as a sympathetic character who reprimands

[13] Edith Hamilton, *Mythology: Timeless Tales of Gods and Heroes* (New York, NY: Warner Books, 1942), 71, 75. However, it should be noted that Shelley's use of the Prometheus myth is problematic in reference to Frankenstein. Although Prometheus overstepped his boundaries to steal fire for man, he is often lauded as a hero for mankind, as opposed to Frankenstein whose transgressions are vilified.

Frankenstein for abandoning him. Through the Creature, Shelley sets up a criticism of Frankenstein's lack of forethought for what might ensue after he reaches his goal and his lack of responsibility towards his creation. Upon their first encounter, the Creature berates Frankenstein, declaring, "Yet you, my creator, detest and spurn me, thy creature, to whom thou art bound by ties only dissoluble by the annihilation of one of us. . . How dare you sport thus with life? Do your duty towards me, and I will do mine towards you and the rest of mankind."[14] The Creature recognizes he and Frankenstein are inextricably bound together and demands that Frankenstein acknowledge he has obligations towards the Creature. To the Creature, who has so far led a solitary life, aware that he would never be socially accepted, Frankenstein's obligation entails making a companion female creature. If he does not, the Creature threatens to destroy all that Frankenstein holds dear.

In recounting his story to Frankenstein, the Creature describes his first days as bewildering and confusing as he tries to navigate his way through the world. He suffers cold and hunger, but delights in the pleasant songs of birds. When drawn to a village because of the possibility of food, he inadvertently frightens some villagers because of his startling and grotesque appearance, but he did not intend to harm anyone. Importantly, the Creature begins his life not as a monster, but as naive and innocent, without resorting to violence. It is not until people treat him as monstrous and he reflects upon their unjust treatment of him that he begins to think of himself as a monster. After a disastrous attempt to make friends with a family, the Creature turns against humanity, declaring war upon man, particularly the one who created him. The Creature as a monster did not

[14] Shelley, "Frankenstein; or, the Modern Prometheus," 960.

emerge until his mistreatment at the hands of man. Despite his best attempts, the Creature is rejected by every person he comes across, and directs his increasing anger and despair at the person he sees as responsible for his suffering, his creator Frankenstein. Readers sympathize with the Creature's plight and see Frankenstein as culpable. They understand how Frankenstein's rejection of and lack of responsibility for the Creature drives the Creature towards revenge. And while readers may disagree with the Creature's subsequent destructive actions, his motives and reasons for acting as such are understandable. Through Frankenstein's thoughtless actions, he is also transformed into a monster. Shelley's story is of two monsters, one who becomes monstrous through his lack of reflection and unwillingness to take responsibility and one who becomes monstrous through inhumane treatment at the hands of others.

Although the Creature serves to criticize Frankenstein's behavior, Shelley also criticizes Frankenstein through the way she structures the story. There are two nested stories, that of Frankenstein and the Creature, housed within a larger narrative in which Frankenstein is rescued by a ship's crew that is stranded in ice at the North Pole. Frankenstein is on his deathbed as he recounts his story to the ship's captain, explaining how he got to his present situation. This nonlinear structure allows Frankenstein to interject comments into his own story, retrospectively reflecting upon his actions. He looks upon his obsessive investigations with dismay, concluding, "A human being in perfection ought always to preserve a calm and peaceful mind, and never to allow passion or a transitory desire to disturb his tranquility. I do not think that the pursuit of knowledge is an exception to this rule. If the study to which you apply yourself has a tendency to weaken your affections, and to destroy your taste for those simple pleasures in which no alloy can possibly mix, then that study is certainly unlawful, that is to say, not benefiting the human mind."[15] He criticizes himself for allowing his obsession to dominate his life for so long, entreating his audience to learn from his tragedies and not allow themselves to become so possessed. However, he later contradicts himself towards the end of the story, and exhorts the ship's crew, some of whom want to abandon their explorations once they are freed from the ice, to "be men, or be more than men. Be steady to your purposes, and firm as a rock. This ice is not made of such stuff as your hearts might be; it is mutable, cannot withstand you, if you say that it shall not. . . Return as heroes who have fought and conquered, and who know not what it is to turn their backs on the foe."[16] Here, Frankenstein calls for the men to stay true to their original goals, regardless of the perils. He seems to have forgotten his earlier exhortations of keeping a tranquil mind and avoiding obsessions. Frankenstein seems incapable of following his own advice, choosing to pursue the goal to the very end despite the dangers. However, the captain acknowledges their slim possibility of success and the crew's growing discontent and chooses to return home once they are freed. By having the captain disregard Frankenstein and abandon the mission, Shelley seems to advocate not letting one's ambitions and goals consume him and ignore the possible consequences. Through Frankenstein's reflections upon his story, readers can imagine Shelley speaking through Frankenstein in criticizing his obsession, while Frankenstein's thoughts remain ambiguous.

[15] Ibid., 934.

[16] Ibid., 1029.

Shelley's story failed to draw much notice upon its first publication, but it gained increasing attention through various adaptations for the stage.[17] Through these adaptations, *Frankenstein* has changed over the years, with the Creature mistakenly called Frankenstein. Some of these changes to the original Frankenstein are reflected in Kurt Vonnegut's play, "Fortitude," which also preserves the original fears about a careless, irresponsible science.[18] Described as a "crass medical genius," Dr. Norbert Frankenstein has only one patient, Sylvia Lovejoy. Through a series of operations over the years, Dr. Frankenstein has replaced her body parts with artificial machinery, with her head as the only part that remains of her original self. The rest is a mess of tubes and wires attached to machinery. Dr. Frankenstein has dedicated his life to keeping Sylvia alive, at least biologically, despite the monetary or psychological cost. Sylvia is his greatest accomplishment. He brags: "They brought in this woman who was beautiful on the outside and a mess on the inside. . . The wise men said again, 'This lady's gonna die.' And I said to them, 'Shut up and listen. I'm gonna tell you what we're gonna do.'"[19] And he does. He builds his whole practice around her to keep her physiologically alive, even if that means turning her into a grotesque human-machine hybrid and controlling her every mood through artificial means.

[17] Richard Holmes, *The Age of Wonder: The Romantic Generation and the Discovery of the Beauty and Terror of Science* (New York, NY: Vintage Books, 2008), 334-335. These stage adaptations made changes to the original story, some of which continue to persist. Frankenstein's laboratory becomes full of mysterious appliances that bubble and fizz with unknown liquids and he is given an assistant who interjects black humor into the story. And the Creature is transformed into the inarticulate and ungainly brute audiences are familiar with today.

[18] Kurt Vonnegut, "Fortitude," in *On Doctoring: Stories, Poems, Essays*, ed. Richard Reynolds and John Stone, 3rd ed. (New York, NY: Simon & Schuster, 2001).

[19] Ibid., 181.

In his typical style, Vonnegut uses black humor to highlight the horrors of modern technology and a science blind to suffering. Through Norbert Frankenstein, he criticizes the cold, hyperrational science that relentlessly pursues knowledge and technological prowess that is oblivious to the suffering it inflicts. Similar to the original, Norbert Frankenstein oversteps the boundaries of acceptable human knowledge and action. He has made a machine-human hybrid whose suffering is apparent to those who care to look. Sylvia appears grotesque and unnerving to others who encounter her, although she is beautiful to Frankenstein. Like his predecessor, Norbert Frankenstein symbolizes an irresponsible science. Both are thoughtless about the consequences of their actions, lacking foresight into what their pursuit of knowledge might mean to others. And like the original, Frankenstein is oblivious to her suffering, faulting the machinery for allowing the disturbances in her typically placid mood. However, while Victor Frankenstein was oblivious to the Creature's suffering because he abandoned it, Norbert Frankenstein is so convinced that the whole of a person's existence, including emotions, feelings, temperament, is strictly attributable to physiological phenomena that he cannot conceive of any other cause. Norbert reduces emotions into a series of chemical reactions, which consequently are artificially controllable, and discounts the possibility that Sylvia's suffering is existential in nature.

Other important differences separate Norbert Frankenstein from Victor Frankenstein. While Victor Frankenstein regards his creation as horrific and rejects the Creature, Norbert Frankenstein dedicates his whole self to keeping Sylvia biologically alive. To him, she represents his power and mastery over nature, a constant reminder of all he has accomplished. His disregard of her suffering and pride in his technical accomplishments over all considerations mark how detached from humanity he has become. While Victor Frankenstein becomes overcome with guilt about his deeds, Norbert Frankenstein feels no such remorse. He is cold and callous, with his objectivity and pursuit of knowledge coming at the expense of any capacity to empathize with Sylvia and her misery. Thus Norbert Frankenstein is no sorcerer's apprentice; he is fully aware of the forces he commands. His actions are deliberate, manipulating nature to do his will. The differences between Victor and Norbert Frankenstein highlight the shifting of the mad scientist over the centuries. In a way, Norbert Frankenstein is an updated version of the mad scientist, with his madness stemming from his obsessive pursuit of extending biological life, even to the point of absurdity, and also from the way he pursues this knowledge—cold, detached, and oblivious to his patient's suffering. Although Victor Frankenstein may have been the prototype of the mad scientist, the differences between Victor and Norbert highlight some of the variations of the mad scientist. He can be a novice or an experienced practitioner, horrified by what he creates or completely enamored of it, and irresponsible through rejection, lack of foresight, or callous obliviousness to the consequences.

The Heartless Scientist: Dr. Moreau and Anti-Vivisection

If the original Frankenstein falls within the sorcerer's apprentice variation of the mad scientist, H. G. Wells's Dr. Moreau, in *The Island of Dr. Moreau*, stands for a significantly different type of mad scientist. Published in 1896, Dr. Moreau can be seen as a predecessor of the type of mad scientist that Norbert Frankenstein typifies. Dr. Moreau maintains an objective distance from his subjects, coldly calculating the next experiment, despite the suffering he inflicts. The novel's narrator, Edward Prendick, tells the story of Dr. Moreau and the experiments he performs on various animals, secluded away on an unknown island. As the sole survivor of a shipwreck, Prendick is brought to the island, where he gradually discovers Moreau's purpose for doing these experiments—to manipulate animals' physiology to give them human characteristics. Moreau searches for the "plasticity of living forms," for creating an "enduring modification" in his subjects, by "transplant[ing] tissue from one part of an animal to another, or from one animal to another; to alter its chemical reactions and methods of growth; to modify the articulation of its limbs; and, indeed, to change it in its most intimate structure."[20] Prendick is horrified by what he finds, by the suffering and cruelty Moreau casually inflicts upon the animals. His stay on the island is nightmarish, filled with Moreau's obsessive and destructive actions, the terror and confusion of the vivisected animals, and their eventual reversion back to bestiality. Like Victor Frankenstein, Moreau is also reckless with his science, pursuing scientific knowledge with a fervor and zeal equal to Frankenstein's He does not consider the consequences of his work, to either the animals he uses or to the unsuspecting public.

However, Moreau is a different type of mad scientist than Victor Frankenstein because of the deliberateness and the intentions behind his actions. While Frankenstein irresponsibly meddles with forces he is ill-prepared to control, Moreau is no amateur to science; he has been methodically and carefully developing his techniques over a number of years. Thus where Frankenstein's naiveté results in his horror and revulsion at his creation,

[20] H. G. Wells, *The Island of Doctor Moreau* (New York, NY: Garden City, 1896), chap. 14, http://www.gutenberg.org/files/159/159-h/159-h.htm.

Moreau experiences no such reaction. Indeed, as a predecessor to Norbert Frankenstein, Moreau embraces his creations, reveling in his scientific and technical prowess and turning a blind eye towards their suffering. Prendick is taken aback by the pain and suffering Moreau inflicts on the animals and so is the reader as Prendick describes a glimpse of one of Moreau's gory experiments: "There was blood, I saw, in the sink,—brown, and some scarlet—and I smelt the peculiar smell of carbolic acid. Then through an open doorway beyond, in the dim light of the shadow, I saw something bound painfully upon a framework, scarred, red, and bandaged. . ."[21] Although the description of the experiment is shadowy, Wells conveys the distinct image that whatever is going on is bloody and painful. Moreau remains deliberately callous to the animals' suffering. His ability to rationalize away the pain he inflicts is chilling: "So long as visible or audible pain turns you sick; so long as your own pains drive you; so long as pain underlies your propositions about sin,—so long, I tell you, you are an animal, thinking a little less obscurely what an animal feels. . . Pain is simply our intrinsic medical adviser to warn and stimulate us."[22] To Moreau, pain is a biological sensation that belongs with the animals, not man. This willful hardness, this deliberate lack of sensitivity makes Moreau a more terrifying type of mad scientist than Frankenstein.

Whereas both Frankenstein and Moreau irresponsibly pursue knowledge beyond the realm of appropriate human boundaries, Moreau's deliberate lack of moral qualms about his work differentiates Moreau from Frankenstein. In Moreau, we see the ideal

[21] Ibid., chap. 10.
[22] Ibid., chap 14.

Baconian scientist taken to the extreme.[23] In discussing his passion for science, Moreau explains:

> I asked a question, devised some method of obtaining an answer, and got a fresh question. Was this possible or that possible? You cannot imagine what this means to an investigator, what an intellectual passion grows upon him! You cannot imagine the strange, colourless delight of these intellectual desires! The thing before you is no longer an animal, a fellow-creature, but a problem! Sympathetic pain,—all I know of it I remember as a thing I used to suffer from years ago. . .
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> To this day I have never troubled about the ethics of the matter... The study of Nature makes a man at last as remorseless as Nature. I have gone on, not heeding anything but the question I was pursuing. . .[24]

Moreau's madness stems from his objectivity, his detachment, his distance, and his narrow focus. The horror the reader feels in this story comes not only from what Moreau does to the animals, but also from his ability to do it in such a deliberately objective and detached manner. His admission that he does not trouble himself with the ethics shows his awareness of the ethical transgressions of his work, but he chooses to ignore them. His deliberate rejection of any kind of empathy with the animals he uses, indeed ridiculing empathy as a weakness, underlies Moreau's madness and the reader's horror at his experiments. Prendick serves to represent the reader's moral sensibilities by reacting with horror and revulsion to Moreau. To Prendick, Moreau is the epitome of a careless, unfeeling science: "Had Moreau had any intelligible object, I could have sympathised at least a little with him. . . But he was so irresponsible, so utterly careless! His curiosity, his

[23] Sherryl Vint, "Animals and Animality from the Island of Moreau to the Uplift Universe," *The Yearbook of English Studies* 37, no. 2 (2007): 87.

[24] Wells, *The Island of Doctor Moreau*, chap. 14.

mad, aimless investigations, drove him on; and the Things were thrown out to live a year or so, to struggle and blunder and suffer, and at last to die painfully."[25]

Published in 1896, *The Island of Dr. Moreau* touches upon many of the scientific issues in public discourse during Wells's day. Situated during a time when scientists were still struggling to establish themselves as figures of authoritative knowledge, ideas in Darwinian evolution threatened to upend man's place at the top of the hierarchy of living things, and opponents of vivisection were vociferously protesting the use of live animals in scientific research, Wells's novel can be read as a commentary on all of these issues. In looking at the story as a commentary on the vivisection debate at the end of the nineteenth century, the term "vivisection" refers to the act of cutting into a living body. Although the term has fallen out of popular use, during Wells's time, "vivisection" more specifically referred to experimenting on live animals for physiological knowledge.

Although experimentation on animals has occurred alongside scientific medicine since its inception in ancient Greece and Rome major, public controversy over the morals and legitimacy of vivisection did not take place until the second half of the nineteenth century. In the vivisection debate, two forces directly clashed: the emergence of experimental physiology as a legitimate path to knowledge and the animal protection movement concerned about cruelty to animals.[26] In England, the Society for the Prevention of Cruelty to Animals was formed in 1824, with many of its members coming from wealthy and upper-middle class society and was backed by powerful figures, such as Queen

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[25] Ibid., chap. 16.

[26] Nicolaas Rupke, "Introduction," in *Vivisection in Historical Perspective*, ed. Nicolaas Rupke (London, UK: Croom Helm, 1987), 5.

Victoria (thus adding Royal to their name). They were concerned about cruelty to animals in general, not only using animals for experiments, but also the animals' working conditions and their use for sport. Concerning the vivisection debate, those against vivisection argued against its utility, its cruelty, and its inherent immorality.

However, vivisection came to the forefront as its practice became more widespread and gained support in the scientific community at large. Prior to the mid-nineteenth century, physiology lagged behind the other sciences because biological entities were thought to be ruled by forces unknowable to man. However, with the advent of experimental physiologists with medical training, "physiology became the determination of the mechanism of the functions of the organism by means of experiments on live animals, instead of the analysis of the so-called vital properties favoured by Xavier Bichat and other medical physiologists."[27] With experiments on live animals, physiology found a path that produced experimentally verifiable knowledge about living processes; living things came to be seen as ruled by universal principles, discernible by man, instead of governed by unknowable forces. Proponents of vivisection "saw animal experimentation as the connecting link between medicine, biomedical research and true science. The experimental model gave to biomedical work its status as an exact science."[28] At a time when other sciences such as physics and chemistry were regarded as legitimate sciences, animal experimentation gave the supporters of biology and physiology a way to establish their

[27] Paul Elliott, "Vivisection and the Emergence of Experimental Physiology in Nineteenth-Century France," in *Vivisection in Historical Perspective*, ed. Nicolaas A. Rupke (London, UK: Croom Helm, 1987), 74.

[28] Nicolaas Rupke, "Pro-Vivisection in England in the Early 1880s: Arguments and Motives," in *Vivisection in Historical Perspective*, ed. Nicolaas A. Rupke (London, UK: Croom Helm, 1987), 199.

practice as a legitimate science and raise their professional and social status. Animal experimentation gained widespread support in medical and biological scientific communities, even amongst those who did not do experimental physiology, for "the pro-vivisection lobby saw itself not just defending experimental physiology, but science in general, its authority and autonomy. The pro-vivisection group was virtually identical with the entire community of medical and biological scientists."[29] The supporters of vivisection were not only defending animal experimentation and the knowledge animal experimentation could yield, but also science's status as source of authoritative knowledge at a time when that status was being contested.

Those against vivisection feared science's cultural ascendancy and criticized animal experimentation on several fronts. Some argued against the utility of vivisection, contesting that knowledge derived from animals could not be applicable in humans. However, most of the criticism against vivisection stemmed from the cruelty inflicted on the animals and the effect that cruelty would have upon those doing the vivisection. The cruelty criticism revolved around the moral status of animals and humans' obligations not to inflict suffering. Previously, moral obligations to others were determined by the others' capacity to reason. However, Jeremy Bentham contested that moral obligations are determined not by the capacity to reason, but by the capacity to suffer.[30] Thus the cruelty argument against vivisection rested on the animals' suffering, which was considerable since anesthesia was not widely used.

[29] Ibid., 202.

[30] Jeremy Bentham, *An Introduction to the Principles and Morals of Legislation* (Oxford, UK: Clarenden Press, 1823), 310-311n.

The other main criticism of vivisection hinged on how those actions would affect the practitioner, particularly those in training. To do animal experimentation, a "vivisectionist had to assume an appropriate role in relation to the dog upon which he operated, he had to distance himself from the emotions which might be aroused by the condition of his patient: self-control was necessary, like that of a surgeon with a patient."[31] The vivisectionist had to emotionally detach himself from empathizing with the animal in order to do the experiment; he had to become intentionally callous towards his subjects and develop a certain level of unfeeling. It was this necessary detachment that worried the anti-vivisectionists, for isn't a physician's ability to empathize with her patients a necessary condition for their humane treatment? Animal experimentation was seen to dull the moral sensibilities of the vivisectionist. Anti-vivisectionists feared this lack of moral sensitivity would lead to other, more objectionable types of experimentation, experiments that would use other vulnerable groups, such as patients, children, or the poor. As articulated by Immanuel Kant, anti-vivisectionists believed "man should abstain from violence and cruelty to animals, because man's compassion for suffering human beings might be weakened and gradually obliterated. The considerate treatment of animals was therefore *man's duty to himself*."[32] A practitioner's moral sensitivity was gauged by his treatment of animals and cruelty towards animals was thought to desensitize the practitioner to suffering of others in general. Adolf Leonard Nordvall, a Swedish philosopher, believed animals have "a

[31] Patrizia Guarnieri, "Moritz Schiff (1823-96): Experimental Physiology and Noble Sentiment in Florence," in *Vivisection in Historical Perspective*, ed. Nicolaas A. Rupke (London, UK: Croom Helm, 1987), 108.

[32] Andreas-Holger Maehle and Ulrich Tröhler, "Animal Experimentation from Antiquity to the End of the Eighteenth Century: Attitudes and Arguments," in *Vivisection in Historical Perspective*, ed. Nicolaas A. Rupke (London, UK: Croom Helm, 1987), 37.

primarily moral function; they exist so that we may practice mercy. Because of this, it is a flagrant breach of morality consciously to cause an animal suffering. The most important point, though, is that the physiologist, the offender against morality, is himself hardened by doing so, and drifts into materialism and nihilism, which he also spreads among his students. Vivisection, then, is a cancer in the body of society, a danger to our culture."[33] Anti-vivisectionists feared what animal experimentation would do to the practitioner. They argued it would cultivate callousness and insensitivity to suffering, eroding the practitioner's capacity for mercy and kindness. This hardness to animal suffering would extend to ignoring the suffering of other humans, and anti-vivisectionists feared this would lead to using vulnerable groups, such as children or the poor, in the name of advancing science. They worried that as science grew in status and authority, this hardness would spread through society, creating a society that ignored the suffering of others.

Wells's Dr. Moreau is the personification of the anti-vivisectionists' worst nightmare, an obsessive experimenter doing whatever horrific animal experiments he pleases, inured to his subjects' suffering, indeed celebrating his capacity to remain unaffected by it. He exemplifies how the vivisectionist creates distance between himself and his work, and how this results in egregious acts of unethical behavior. Although little evidence exists that explicitly connects Wells to the vivisection debate, given the ardor of the anti-vivisectionists and their outspoken tactics, Wells almost certainly would have been at least somewhat familiar with the controversy. Wells's depictions of the vivisection debate and the anti-vivisectionist actions in the story all closely follow the actual fears and concerns in

[33] Lennart Bromander, "The Vivisection Debate in Sweden in the 1880s," in *Vivisection in Historical Perspective*, ed. Nicolaas A. Rupke (London, UK: Croom Helm, 1987), 220.

the public debates and their manifestations in pamphlets and news articles.[34] Moreau's character encompasses the two-fold fears of the anti-vivisectionist—violating the animal's inherent dignity by subjecting them to horrific suffering and enabling this wanton cruelty by dulling his moral sensitivities to such an extreme degree. In Moreau, the anti-vivisectionists found a foil, someone to stand as a warning for what could happen to physicians and scientists if animal experimentation were allowed to happen.

While Moreau and his actions are undoubtedly reprehensible, some suggest the story should not be read as a complete condemnation of science and animal experimentation. Prendick reveals himself to be an amateur scientist, who has spent some time at the Royal College of Science and has done some researches under Huxley. Because of Prendick's dual status as public representative and amateur scientist, Martin Willis argues Prendick's interest in science paints him as sympathetic to the scientific cause, including humane animal experimentation.[35] As Moreau symbolizes the horrors of mad, irresponsible science, Prendick can be seen as representing a more tempered view of science, one that argues for a thoughtful and cautious practice of science.

Moreau, with his secluded laboratory secreted away on an unknown island and his fantastic manipulations of animals into the likeness of man, may seem too bizarre and far-fetched a caricature to be able to yield any insight into the real-world scientist. However, when *The Island of Doctor Moreau* is paired with the contemporary vivisection debates, *Moreau* gives a voice to the anti-vivisectionist stance by graphically showing the potential

[34] Martin Willis, *Mesmerists, Monsters, and Machines: Science Fiction and the Cultures of Science in the Nineteenth Century* (Kent, OH: Kent State University Press, 2006), 219-220.
[35] Ibid., 219.

consequences of vivisection. The story becomes a warning for what kind of mad science could develop if vivisection were allowed to proceed unregulated. Moreau's transformation of animals into humans is undoubtedly taken to extremes, and Moreau is certainly an exaggeration, but the anti-vivisectionist fears that run through the story are legitimate concerns. Questions still linger about the moral obligations society owes animals and the humane treatment of animals in scientific experiments, as well as concerns about the necessary distancing of the practitioner in order to do these experiments and how this distance can dull the practitioner's moral sensitivities. Although the story is extreme, readers of *Moreau* are vividly shown the real moral issues that continue to be entangled with animal experimentation. While an in-depth discussion of animal rights is beyond the scope of this work, I raise it to show an example of how *Moreau* and the anti-vivisection debates of the late nineteenth century can be used as an example of how fiction and reality can intersect to highlight some issues at stake.

It's a Mad, Mad, Mad, Mad World

Wells's struggle with vivisection in *The Island of Dr. Moreau* and the modern scientist's madness as partially rooted in his hyperrationality and emotional detachment have found a contemporary incarnation in Margaret Atwood's 2004 speculative fiction, *Oryx and Crake*.[36] The novel is set in the not too distant future, opening with the catastrophic ending of a dystopian society. Through the story's narrator, Snowman,

[36] Although *Oryx and Crake* is sometimes classified as science fiction, Atwood rejects this category. She argues science fiction "denotes books with things in them we can't yet do or begin to do" while speculative fiction "employs the means already more or less to hand, and takes place on Planet Earth." From Margaret Atwood, "The Handmaid's Tale and Oryx and Crake 'In Context'," *PMLA* 119, no. 3 (May 2004), 513.

formerly called Jimmy, readers learn that advances in science and technology for financial profit are the primary driving force in this society. It is a society without morals or scruples, placing scientific advancements for financial gain above all other considerations, moral ones included. Companies continuously churn out products that promise prolonged youth, smoother skin, happier and healthier lives to the consumers that demand them. These companies literally enclose the scientists and their families within the safe and sterile walls of corporate compounds, separating and blinding them to the chaos and plagues of the poor in the pleeblands. It is an elitist and technologically driven society. Most that live within these compounds are scientists who work for various corporations, such as OrganInc Farms, Helth Wyzer, or RejoovenEsense, who manipulate nature to yield products that are as commercially profitable as possible. Jimmy's father worked for OrganInc Farms, where he was one of the leaders on the pigoon project, a project that aimed to

> grow an assortment of foolproof human-tissue organs in a transgenic knockout pig host—organs that would transplant smoothly and avoid rejection, but would also be able to fend off attacks by opportunistic microbes and viruses, of which there were more strains every year. A rapid-maturity gene was spliced in so the pigoon kidneys and livers and hearts would be ready sooner, and now they were perfecting a pigoon that could grow five or six kidneys at a time. Such a host could be reaped of its extra kidneys; then, rather than being destroyed, it could keep on living and grow more organs. . . That would be less wasteful, as it took a lot of food and care to grow a pigoon. A great deal of investment money had gone into OrganInc Farms.[37]

The pigoon hosts are the medium for the human organs, treated as merely a means to an end. In this world, everything is a resource that humans can manipulate for their own gain.

[37] Margaret Atwood, *Oryx and Crake* (New York, NY: Anchor Books, 2003), 23.

Any consideration given to the pigoons towards their quality of life is only contingent upon how productive and cost saving they can be for OrganInc. Just as the anti-vivisectionists feared at the close of the nineteenth-century, animals are no longer considered to have their own intrinsic value. Their sole function is to serve as means for human ends.

Animals are genetically manipulated with abandon, creating bizarre and alarming hybrids, such as rakunks (raccoon and skunk) or snats (snake and rat). Where the rakunk is cuddly and becomes a popular pet, the snat is an unfortunate blend and destroyed soon after its creation. However, while some genetic manipulations are planned to be profitable, such as the pigoon project, the rakunks and the snat are done because they can be done: "create-an-animal was so much fun, said the guys doing it; it made you feel like God."[38] Science proceeds unchecked. What is pursued is sometimes done because it can be, for the amusement of the scientists. Thought is not given to the plight of the animals used and discarded; they are not seen to have any moral claims upon humans that would limit their abuse. To the companies and those within the safety of the walls, those outside are not considered to have any more moral claims than the animals. When recruiting human subjects, researchers turn towards the vulnerable and the exploited. The subjects come from "the poorer countries. Pay them a few dollars, and they don't even know what they're taking. Sex clinics, of course—they're happy to help. Whorehouses. Prisons. And from the ranks of the desperate, as usual."[39] And these activities are sanctioned by society; they have become part of the normal functioning of society. Any transgressions made in the

[38] Ibid., 51.
[39] Ibid., 296.

name of research are ignored or dismissed. Society demands these products, disregarding their costs and their consequences.

In this novel, the entire practice of science is mad. This mad science, with its unmitigated and unreflective advancement, is stretched beyond the purview of any one individual scientist, but has become science's, and society's, norms and values on a widespread scale. Animals and humans are manipulated, spliced, and consumed, to further scientific and commercial ends, and they are promptly discarded once they are no longer of use. Atwood touches upon the anti-vivisectionist fears of what might result by allowing biomedical science to gain legitimacy as a source of authority, expanding mad science to encompass the entire practice of science, to the entire functioning of society. Science as a whole acts without regard to its consequences, both in the products it releases to the public and the means it uses to develop them. It is irresponsible and unreflective, driven by commercial gains, or simply undertaking projects because it can, to test its own limits. Insensitivity to suffering and the plight of others is widespread, with scientists using whatever resources they want, however they want, to develop products. The nonscientist members of society are complicit in these moral breaches by demanding the products that make them younger, sexier, more perfect and by ignoring the means science uses to develop them. The unchecked, irresponsible obsession for scientific knowledge has become the norm. No longer is the mad scientist a shadowy figure working on the fringes of society, but the mad scientist is the ordinary scientist.

Amongst this technology-driven society are Jimmy and Crake. In a way only childhood friends can, Jimmy and Crake have a lifelong friendship, despite their differences.

Jimmy is a "words person," a "neurotypical" ("Minus the genius gene"), while Crake is a scientific genius among geniuses. Crake is a "numbers person," so brilliant at math and science that he sees the world in those terms. Once when Jimmy and Crake see their teacher with an older man, with his arm around her waist, in a burst of adolescent humor, Jimmy wonders aloud if the man's hand is on their teacher's rear. Instead of playing along, Crake responds, "That's a geometrical problem. You'd have to work it out. . . Step one: calculate length of man's arm, using single visible arm as arm standard. Assumption: that both arms are approximately the same length. Step two: calculate angle of bend at elbow. . ."[40] To Jimmy, the question was just for his teenage amusement, a bit of scandal to invent, but to Crake, who has no such imaginings, it is merely a question with a mathematical solution. To Crake, everything that matters can be explained and solved through math and science, through reasoning and strategy, and whatever cannot, is irrational and irrelevant. In the tradition of Dr. Moreau and Victor Frankenstein, Crake is amoral and hyperrational, attributing emotions to an unfortunate series of hormonally driven reactions. He is not particularly concerned with how something is done, just that it is done. About the various genetically engineered products, Crake tells Jimmy, "After it happens, that's what they look like in real time. The process is no longer important."[41]

In a world where science reigns, Crake is king; he is the best scientist and he is the maddest of them all. Crake attends the top university, the Watson-Crick Institute, where students are incentivized to develop marketable products, receiving half the royalties from anything developed there. From there, he quickly ascends to the upper ranks of

[40] Ibid., 74.
[41] Ibid., 200.

RejoovenEsense, one of the most powerful companies, and soon secures his own unit, the Paradice project. One of his main focuses on the Paradice project is the BlyssPluss pill. This pill is designed to "protect the user against all known sexually transmitted diseases," "provide an unlimited supply of libido and sexual prowess," and "prolong youth." It has a fourth capability that is not advertised; it acts as "a sure-fire one-time-does-it-all birth-control pill."[42] With the growth of human population outpacing available resources and space, the pill is designed to satisfy the sexual and superficial urges of the masses, while also curbing the population growth. However, something else has been embedded into the pill, a bioform that quickly decimates the human population. Unbeknownst to everybody, Crake placed this agent into the pill, intending to fix all the misery, violence, and greed of humans by destroying everybody.

Crake is undoubtedly mad in his destruction of humanity. However, his actions are in reaction to the madness of the technology-driven, materialist culture. While the mad scientists previously examined do not consider questions of ought, therefore conducting science irresponsibly, Crake's kind of madness differs a bit. Seeing the current social conditions as untenable, that humanity will consume itself unless something is done, Crake responds by destroying it himself. Although it causes mass hysteria and suffering, Crake sees his way as better than allowing society to slowly bring on its own prolonged demise. In an irresponsible society, Crake sees his actions as responsible and reasonable. In this way, Crake is not amoral, but immoral. Even though he seems to have convinced himself that he

[42] Ibid., 294.

is indifferent towards moral questions, his eventual actions show how concerned he is with moral questions, even if he is not willing to admit them as such.[43]

Jimmy is inoculated against the bioform that destroys the rest of humanity and survives to bear witness to the destruction and to tell its story. He is the reluctant hero, telling the story of the end of the world, while also trying to figure out why Crake chose him to be the teller. Jimmy recognizes his complicity in the destruction of humanity, by the mere fact of his inclusion in it, but he is the only one in the story who gives voice to any moral qualms. He quietly and fleetingly worries about science's transgressions, the boundaries crossed that science so proudly flaunts. Jimmy brings the reader into the story, helping them navigate a chaotic, shocking world, but also serving as a small space to voice concerns over the direction of our own society. Atwood creates a society that is an exaggerated version of our current situation; it is familiar enough that readers recognize the world in *Oryx and Crake* as a situation they may soon find themselves in.

In an epigraph, Atwood foregrounds her intentions by quoting from Jonathan Swift's *Gulliver's Travels*: "my principal design was to inform you, and not to amuse you." She crafts her story to explore her premise of "What if we continue down the road we're already on? How slippery is the slope? What are our saving graces? Who's got the will to stop us?"[44] Atwood takes the present circumstances and then imagines their development if allowed to proceed uninhibited. She places the novel in the not too distant future and

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[43] *Oryx and Crake* is the first in a trilogy, with the second, *The Year of the Flood*, published six years later. The second novel is not quite a sequel, but a companion to the first, with Crake appearing intermittently as a minor character. In it, there are hints that Crake has more moral concerns than he appears to have in the first novel.

[44] J. Brooks Bouson, "'It's Game over Forever': Atwood's Satiric Vision of a Bioengineered Posthuman Future in Oryx and Crake," *Journal of Commonwealth Literature* 39, no. 139 (September 2004): 140.

using hyperbole, "forces a second look at contemporary life, revealing the power plays, marketing strategies, and processes of mythography that are already at work in its construction and constant re-realization."[45] As mad scientists stand as cautionary figures, *Oryx and Crake* serves as a cautionary tale for the future if scientific and commercial interests are allowed to continue unchecked. If *The Island of Dr. Moreau* reflects anti-vivisectionist fears at the end of the nineteenth century, *Oryx and Crake* builds upon those fears by imagining the consequences of a technologically and commercially driven society obsessed with materialism and a science allowed to advance unrestrained, using whatever means it desires. Although there is no evidence that Atwood recognizes her story as a descendant of the anti-vivisection debate, in a sense, Atwood finishes a story that Wells and the anti-vivisectionists start. The moral erosion anti-vivisectionists feared would happen with animal experimentation is taken to an extreme conclusion by Atwood. In imagining the world of *Oryx and Crake*, she shows what could happen if animals and vulnerable people are considered as resources to be used and discarded, if an entire society's moral sensitivities are dulled, and if science is allowed to become the only legitimate way of viewing the world.

Conclusion

The stories of both Dr. Frankensteins, Dr. Moreau, and Crake are imaginings of a science gone mad, an unreflective, obsessive, irresponsible science that never pauses to consider its widespread repercussions. Although the scientist characters discussed and the

[45] Grayson Cooke, "Technics and the Human at Zero-Hour: Margaret Atwood's Oryx and Crake," *Studies in Canadian Literature* 31, no. 2 (2006): 117.

science they practice are caricatures of how science is actually practiced in the real world, they help bring together and forcefully illustrate deep concerns about how science is changing what it means to be human. They crystallize concerns about science's directions, creating a space for the wary to develop cautionary tales. And they illustrate how science's moral features extend through the entire practice of science, that the scientist's character is central to practicing science well. They illustrate that science and its products cannot be judged solely by how they are used, but that the scientist's motivations, intentions, and reflections on her work's consequences are critical in shaping science's relationship with society. Indeed in the works discussed, while the products of science serve to highlight the possible consequences of what science might bring, much of the horror of mad science lies with the scientist's character and his lack of reflection, empathy, or foresight. The stories show, that regardless of the products, there are immoral ways of doing science that scientists should avoid. The stories of mad scientists bring together concerns about an irresponsible, unreflective practice of science with science as a source of authoritative knowledge, with the scientist's desire for objectivity and rationality, with animal experimentation and genetic manipulation. These stories imagine the potential consequences of the values science houses and the directions it takes.

What is it about the mad scientist that persists over the years, despite its various permutations? How can Shelley's Frankenstein continue to stand for an out-of-control, irresponsible science, even though it has undergone considerable distortions? How can Dr. Moreau endure as a symbol of an inhuman, reckless science that eventually results in Crake? Although science has changed considerably since Shelley's time, the fears and anxieties that fuel the continuance of the mad scientist are still very much alive. With the development of genetic, reproductive, and various life-extending technologies, science is skirting dangerously close to trespassing on knowledge best left alone or possibly bringing about the annihilation of the human species. Enmeshed in the worries about science are fears about reaching the boundaries of appropriate human knowledge and having the capacity to recognize them if those boundaries are reached.

If there are boundaries to what science should know and to the influence it exerts or if ther are moral and immoral ways of doing science, then moral traditions, such as virtue ethics, can serve as rich resources to help identify how science should be practiced and how to recognize and deliberate well about those boundaries. How, then, can virtue ethics help work through science's moral and social features? Although the mad scientist is a caricature that stands in opposition to that careful, deliberative moral agent, he can serve as a cautionary figure that warns the virtuous scientist what traits to avoid. As virtue ethics is concerned with examining the contours of a situation to lead to wise decisions, the errors of the mad scientist may be brought to help foster the development of the real-world scientist's character.

In the mad scientist's reckless pursuit of knowledge, "we come to the uncomfortable conclusion that in many cases we are actually looking into a mirror, as modern medical marvels increasingly force us to examine not only our own mortality, but just how far each of us may be willing to go to control our own bodies and even delay the time of our death."[46] Some of the human desire for immortality, for power, for creation,

[46] Larsen, "Frankenstein's Legacy," 48.

held in tension with human fears that science's reach extends beyond boundaries that perhaps should not be crossed, at least not without deep reflection upon the issues at stake. The mad scientist's yearnings may lead to the wholesale pursuit of them. Instead of being tempered by fears about science's methods and goals, those yearnings may prevail and may be supported on a widespread scale. The world in *Oryx and Crake* is not only terrifying in its destruction of the human race, but also distressing because it is so recognizably based in our present situation. The society-wide support of prolonged youth, never-ending sexual prowess, and protection against all forms of disease and illness has become the overweening values of that world.

What science may develop and what scientists learn cannot be unlearned. For part of the fear about science is not only what may be developed and used, but also that once the knowledge or products come into existence, they cannot disappear and there is no going back. Scientists will have the power to bring science's knowledge and products at their discretion because the ordinary person is left powerless when it comes to the inner workings of science and its directions. Roslynn D. Haynes writes succinctly, "The fear of science is about power and about change that leaves the ordinary person disempowered and confused, unable to control either the ideas or the people who may exploit them. Unlike rulers and military juntas, knowledge cannot be overthrown; it cannot be put back in the box."[47] Science is largely closed to the ordinary person; its pursuits are mysterious and unknowable. It is this fear of the unknown and the uncontrollable, combined with the impossibility of retracting knowledge, that allows stories of mad scientists to persist.

[47] Roslynn D. Haynes, "From Alchemy to Artificial Intelligence: Stereotypes of the Scientist in Western Literature," *Public Understanding of Science* 12, no. 3 (July 2003): 244.

With science (and a scientific outlook) as one of the most compelling voices of the time, it edges out the traditional narratives that teach how to live, prescribe rules of conduct, tell of human origins, and give a sense of continuity and purpose.[48] Although science can tell a great deal about the principles by which the natural world works, it does not deal with questions about ought—should society pour countless resources, dollars, and hours into a line of research? Are there boundaries that should not be crossed? And if there are, how will they be recognized? The shifts that science brings may happen gradually, slowly without awareness of their even occurring. By the time society becomes aware of this gradual erosion of values and morals, it will be too late. What is learned cannot be unlearned and what is done cannot be undone. In justifying scientific advances that push the limits of what it means to be human, society may begrudgingly accept them, while also furthering moral erosion. If science is allowed to be conducted irresponsibly and society lacks the moral compass needed to detect that irresponsibility, what might eventuate is fearsome.

All of these fears are encompassed in the depictions of mad science and affect scientists and the practice of science in profound ways. These fears affect how scientific developments are received by nonscientists, which, in a cyclical fashion, have an impact on how scientists do their work. However, the stories about mad scientists can have a more direct bearing upon the scientist's practice. The stories about mad scientists serve as a locus for the real-world scientist to further unpack and explore the various issues the stories touch upon. Through reading these stories, and familiarization with the contexts in which

[48] Stephen Dunning, "Margaret Atwood's Oryx and Crake: The Terror of the Therapeutic," *Canadian Literature* 186 (Autumn 2005): 86-88.

they were written, practicing scientists can become explicitly cognizant of the moral and ethical issues that surround their own research. The scientist can begin to trace the development of those issues and piece together the connections between those issues and their own work. They can see how their character has a direct bearing on whether or not their science is ethical, that their intentions and motivations influence how they craft their work. For a virtuous science, this type of contextualization is necessary. Reliance on a solely scientific perspective for conducting present and planning future research prevents the scientist from realizing science's *telos*, which places ethical considerations alongside scientific ones. As the mad scientist figure informs the public's relationship with science, understanding what fears this figure represents about scientists and science is important when contextualizing science. Using the stories of mad scientists, real-world scientists can begin to explore the fears that surround their work and cultivate the *phronêsis* that requires them to consider moral questions, alongside their scientific ones.

Chapter 6: The Heroic Scientist

If the figure of the mad scientist presents one extreme, then the figure of the heroic scientist presents a different kind of extreme. Similar to how the mad scientist encompasses the fears about an irresponsible, unreflective science that runs amok, the heroic scientist encapsulates the support for and faith in science's ability to produce technological solutions to human misery. This figure valorizes scientists as noble, sacrificing people who are servants of the greater good. The heroic scientist holds dear the pursuit of knowledge for its own sake or for the benefits it may yield, all the while strictly adhering to scientific methods and principles. Like mad scientists, the heroic scientist's character, intentions, and motivations matter a great deal in shaping the course of his work. While the mad scientist's intentions and motivations are vilified, for the heroic scientist, they are lauded. The image of the heroic scientist contributes to science's authority as a legitimate source of knowledge by celebrating science's successes.

In a sense, the heroic scientist stands in diametric opposition to the mad scientist. He is noble, motivated by the desire to benefit science and society, working with society's approval, where the mad scientist undertakes ethically dubious work, shrouded in mystery and unreflective about his work's consequences. They are similar in that both function as exaggerations of ordinary scientific practice taken to extremes, residing at opposite ends of the spectrum. While they are opposites about what kind of messages they send about science, in underscoring their message, they are both exaggerations of science's values. The heroic scientist is often used to stand as a positive symbol for science; it should be closely examined to understand what characteristics make it heroic and what ethical issues are intertwined with and often overshadowed by that positive symbol. While the mad scientist's ethical transgressions are often prominently displayed, the heroic scientist's ethical misdeeds are often shunted to the side. Sometimes the line between heroism and madness in science is blurry, as the same characteristic can be interpreted differently depending upon the author's purpose. Science's values of objectivity and rationality are often embodied by both mad and heroic scientists and are often the root of their madness or heroism, but are presented from significantly different stances, an issue that will be further discussed later in this chapter.

Like the figures of the ordinary and mad scientist, a critical examination of the heroic scientist is important for the real-world scientist for cultivating *phronêsis*. By examining the heroic images of the scientist, the real-world scientist can begin to explore another facet of science—the faith placed in and authority given to science—examining it to further develop her understanding of science's relationship with society. In parallel with the mad scientist, studying the heroic scientist with these purposes in mind can help the real-world scientist cultivate *phronêsis* by further contextualizing her work with the public's hope in the goods science may yield. Like the mad scientist, the heroic scientist can serve as a beginning point for the real-world scientist to unpack ethical issues. However, the real-world scientist should also be alert to possible ethical transgressions committed that may be overlooked when constructing a positive image of science. That positive image may overshadow those issues and the real-world scientist should remain aware that a positive image of science, at times, depends upon ignoring the ethical transgressions.

In this chapter, I will discuss the figure of the heroic scientist, focusing on the various features of the heroic scientist, the heroic scientist's relationship to the practice of science, and the hopes and desires the heroic scientist encapsulates. I will first discuss the qualities of the heroic scientist and some of the variations within that image. I will then turn to discussing the construction of the heroic image, by focusing on what values are prominently emphasized and what issues are often overlooked.

Fearless Science: The Figure of the Heroic Scientist

Like the figure of the mad scientist, the figure of the heroic scientist exaggerates science's methods and values. Although heroic scientists may vary somewhat, they all have internalized science's values of rigorous experimentation, objectivity, and dedication to discovering truth, despite the hardships they may encounter and the sacrifices they may need to make. Their dedication to discovering truth using experimental means and the sacrifices they are willing to make are hallmarks of the heroic scientist. However, while the mad scientist may be as dedicated to finding knowledge through scientific means as the heroic scientist, in the heroic scientist, this dedication is lauded as necessary and noble. Like the mad scientist, the heroic scientist is single-minded in his pursuit of scientific knowledge. However, for the heroic scientist, this dedication favorably reveals the scientist's deep commitment to rigorous scientific methods and values, enabling him to pursue science's goods of generalizable truth and social benefit; it is what makes him a true scientist. For many heroic scientists, this dedication is demonstrated through various acts of self-sacrifice, whether through eschewing material comforts or disregarding his health by engaging in risky behavior.

Historian of science Rebecca M. Herzig further discusses the significance of a scientist's sacrifice and how that sacrifice contributes to the figure of the heroic scientist. A sacrificial act, she says, "implies a loss suffered, an uncompensated expenditure, an unrestricted offering."[1] Thus a sacrificial exchange is uneven for those involved; it entails one party giving something up for another, but with a loss of some sort, while the other party suffers no such loss. In this type of exchange, what this meant for science "was whether science might present an alternative to the tyrannical logic of the marketplace—whether it could, or ought to, be freed from the profane presumptions of the self-interested contractual exchange."[2] Through sacrifice, science bypassed the typical contractual exchange of the marketplace, making the knowledge generated more like a precious gift instead of a product with monetary value. Conceptualizing knowledge as a priceless gift became integrated into science's identity, with the search for knowledge as something closer to the sacred than to the profane. Within this framework, the image of the heroic, sacrificing scientist wholly dedicated to searching for a greater good (truth or societal benefit) emerged. He sought knowledge through scientific means because that is what he was meant to do, not because of how he may benefit. Material rewards were thought to be beneath the heroic scientist's concerns.

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[1] Rebecca M. Herzig, *Suffering for Science: Reason and Sacrifice in Modern America* (New Brunswick, NJ: Rutgers University Press, 2005), 6.

[2] Ibid.

Then for the scientist to be self-sacrificing for science, he must give up something valuable of himself, which could be material or physical, actual or potential. However, Herzig argues the meaning and significance of that sacrifice hinges on his ability to be self-possessed, that is, to be socially recognized as able to have possession of one's self, based on certain characteristics, and to voluntarily choose to sacrifice something of himself. In America, the idea of self-possession grew through the eighteenth century, during which "possession of the *self*, rather than possession of dispensable capital, became the politically consequential form of proprietorship. In the years leading up to the war, self-ownership came to be the defining condition of civic participation."[3] Although this can be discussed at much further length, I raise this point to emphasize that as the self became a form of proprietorship, this ability to own one's self then allows that person to voluntarily choose to give up the self. However, self-possession was not available to all people; only certain bodies were recognized as able to be self-possessed, thus able to self-sacrifice. As self-possession was linked to civic participation, those recognized were mostly white men, to the exclusion of women and non-whites. The ability to willingly choose self-sacrifice is critical to the act's significance, for a sacrifice derives its meaning from the awareness of the loss engendered and the intentional execution of the act. Thus, with the socially recognized capacity for self-possession, the self-sacrificing scientist is transformed into a heroic figure by voluntarily renouncing the comforts and pursuits of the ordinary man.

However, voluntarily choosing self-sacrifice was not enough; the scientist's reasons for self-sacrifice were also important. To be recognized as sacrifice, "the sacrificial act

[3] Ibid., 21.

must remain purposeful lest it be confused with simple self-destruction. The investigator who ate tapeworms just to eat them would not be giving something of himself for science; he would simply be deranged, degenerate, ignoble. . . . The scientist could never strategically barter suffering for knowledge since exchanging blood or labor in order to acquire a new fact annulled the meaning of the gift. For these proponents of self-sacrifice, an evident lack of compensatory reason is precisely what preserved the special status of the self's offering."[4] The scientist's reasons for self-sacrifice must be noble enough, which usually would be either furthering scientific knowledge or benefiting the public. And the self-sacrificing scientist cannot carry out an act expecting compensation or on just a whim. Self-sacrifice is then constructed as an act freely chosen by the investigator with the aim of generating new scientific knowledge, who acts with the right motivations, who is aware of the loss engendered and the lack of compensation. However, he also cannot expect to produce new scientific knowledge, but must merely hope that his hard work may one day be rewarded by new knowledge.

Many traits of the heroic scientist can be thought of as a type of self-sacrifice. As will be further discussed, the heroic scientist often eschews material comforts or personal relationships, and occasionally risks physical harm, for the sake of his research. Resulting from these defining qualities are different ways the scientist can sacrifice. A scientist's self-sacrifice then can take various forms, such as putting himself at risk of injury or illness, foregoing material comforts and fame, or denying himself relationships with other people that would distract him from his work, all for the pursuit of truth and the goods.

[4] Ibid., 39.

In addition to self-sacrifice and its related features, other traits constitute the heroic scientist figure. As previously mentioned, the scientist's dedication is critical to self-sacrifice and is an important hallmark of the heroic scientist. Regardless of whether the heroic scientist is researching for scientific truth or for societal benefit, his dedication to his goal keeps him focused. Closely related to his dedication to science is his curiosity in science. While his dedication keeps him continually pursing science, his curiosity helps him devise his next research plan. His curiosity in science, his continued desire for more knowledge, causes him to ask a never-ending series of questions and develop experiments that could help answer those questions. Additionally, courage is often characteristic of the heroic scientist. While the heroic scientist may deliberately choose to self-sacrifice, sometimes it takes courage to make that decision and follow through with it. The heroic scientist often has significant obstacles in his path to scientific knowledge, whether they may be external distractions that prevent him from doing his work or internal struggles of doubt and confusion. Although he willingly and gladly participates in science, confronting and overcoming these obstacles can be daunting, requiring the heroic scientist to draw upon his courage.

With this rough sketch of the heroic scientist's characteristics, I now turn towards focusing on the area of science that has produced some of the most lasting images of the heroic scientist, the fields of bacteriology and virology at the beginning of the twentieth century. I will discuss literary and historical images of heroic scientist to examine what characteristics they possess that renders them heroic and how, despite their heroic construction, they bear striking similarities to the mad scientist.

The Makings of a Hero: Martin Arrowsmith, Louis Pasteur, and Walter Reed and the Yellow Fever Commission

Although the biomedical sciences have gained in popularity and authority since the mid-nineteenth century, the belief in them as able to alleviate the majority of human suffering reached its peak in the first half of the twentieth century. Depictions of heroic scientists in popular literature corresponded with this increase. As bacteriology and virology, and later microbiology, grew, scientists working in that area made startling breakthroughs in understanding disease causation, transmission, and control. Dreaded diseases were shown to be caused by microscopic organisms, and with that discovery, a beginning point emerged for understanding the diseases' cycle, their control, and prevention. Although finding cures for diseases entails much more than identifying the causative agent, by identifying their causes, those infectious diseases became less fearsome, more manageable. In finding the causes, the development of cures and preventive measures seemed more attainable. Scientists who made these discoveries were lauded as saviors who freed the public from plagues; they were positioned as guardians of society's health and well-being who stood against the terrors of disease. By the first decades of the twentieth century, mortality from these once-feared diseases was on the decline. Although the decline can be attributed to a multiplicity of causes, such as development of sanitation and clean water infrastructure, rising standards of living, and government regulation of sanitation, as well as these advances in bacteriology,[5] scientists in bacteriology who discovered the causes of the

[5] Gerald N. Grob, *The Deadly Truth: A History of Disease in America* (Cambridge, MA: Harvard University Press, 2002), 200-201. For further reading about how public health developed in America and how it helped eliminate many deadly diseases, see John Duffy, *The Sanitarians: A History of American Public Health* (Urbana, IL: University of Illinois Press, 1990).

diseases and worked towards their cures, stood as visible and vocal symbols that could receive the credit. For their discoveries, they were rewarded with increased prestige, authority, and an increased visibility within the public sphere. The subsequent discussion of heroic scientists will concentrate on those within bacteriology because the discoveries bacteriology produced in the late nineteenth and early twentieth centuries yielded many impassioned depictions of the heroic scientist.

Perhaps one of the most influential and vivid depictions of the heroic scientist is Martin Arrowsmith in Sinclair Lewis's *Arrowsmith*. Written in 1925, *Arrowsmith* can be read as a *bildungsroman* of American medicine in the first half of the twentieth century. Through the training, growth, and wanderings of Martin Arrowsmith, the reader is exposed to various stages of American medicine's development from something carried out by individual physicians and taught through an apprentice system to a body of knowledge that becomes institutionalized and is formally taught in medical school and intimately connected with scientific practice. In the novel, the reader follows Arrowsmith as he becomes a young physician and moves from one medical setting to another. Despite his training as a physician, from early on in his university education, he becomes enamored with doing science, in part inspired by one of his teachers, Max Gottlieb. Gottlieb who teaches bacteriology at Arrowsmith's university, is shrouded in mystery:

> It was known that he was a Jew, born and educated in Germany, and that his work on immunology had given him fame in the East and in Europe. He rarely left his small brown weedy house except to return to his laboratory. . . It was believed that he was the son of a German prince, that he had immense wealth, that he lived as sparsely as the other professors only because he was doing terrifying and costly experiments which probably had something to do with human sacrifice. . . .

> His swart cheeks were gaunt, his nose high-bridged and thin. He did not hurry, like the belated homebodies. He was unconscious of the world. He looked at Martin and through him; he moved away, muttering to himself, his shoulders stooped, his long hands clasped behind him. He was lost in the shadows, himself a shadow.
>
> He had worn the threadbare top-coat of a poor professor yet Martin remembered him as wrapped in a black velvet cape with a silver star arrogant on his breast.[6]

Written at a time when German science was the premier way of practicing science, *Arrowsmith* presents Gottlieb as the German scientist in America who stands as the definition of the dedicated scientist that Arrowsmith very much wants to become. And instead of repelling Arrowsmith, as this characteristic might when expressed by the mad scientist, Gottlieb's aura of mystery and dedication further attracts Arrowsmith. Gottlieb stands as a symbol for "not only the transfer of European knowledge and techniques to the New World, but an expression of the peculiar mystique of German academic life. His worship of research *qua* research and his reverent attitude toward this pursuit of knowledge are very much the product of the German university."[7] Gottlieb represents science in its purest form—the German way of doing science, in which the science is rigorous and exacting, but also a type of higher calling.

Gottlieb is austere in his practice of science, demanding the most rigorous methods and accepting only the most well-evidenced arguments. He privileges basic science and scoffs at those interested in science for its utility, seeing science as a quest for truth not to be debased by motives of profit or other tangible benefits. He lives an ascetic life, denying himself material comforts and foregoing relationships with nearly everybody, preferring the

[6] Sinclair Lewis, *Arrowsmith* (New York, NY: Signet Classic, 1925), 8-10.

[7] Charles E. Rosenberg, "Martin Arrowsmith: The Scientist as Hero," *American Quarterly* 15, no. 3 (Autumn 1963): 452.

solitude of his laboratory. He exists to uncover scientific truth which demands the most rigorous science. Gottlieb is characterized as somewhat of an otherworldly man, one whose body is physically present, but whose mind is constantly searching for greater, higher truths; he lives in his own world, with his never-ending search for scientific truths as his major concern. However, it is important to keep in mind that these characteristics that render Gottlieb an idea scientist are also hallmarks of the mad scientist and their similarities will be later discussed in more detail.

Although he appears shabby to most people, Arrowsmith sees Gottlieb through the transformative power of science. The worthy pursuit of scientific truth has rendered Gottlieb himself noble and dignified in Arrowsmith's eyes and Gottlieb becomes Arrowsmith's exemplar of science at its best. Although Arrowsmith initially bounces from one type of medical practice to another, which prevents him from dedicating himself to his experiments as much as he would like, he eventually lands at the McGurk Institute, a place roughly modeled on the Rockefeller Institute and dedicated to scientific research. There, he reunites with Gottlieb, whom Arrowsmith had not seen since his medical school days. At their meeting, Gottlieb tells Arrowsmith what it means to be a true scientist:

> To be a scientist—it is not just a different job, so that a man should choose between being a scientist and being an explorer or a bond-salesman or a physician or a king or a farmer. It is a tangle of very-y obscure emotions, like mysticism, or wanting to write poetry; it makes its victim all different from the good normal man. The normal man, he does not care much what he does except that he should eat and sleep and make love. But the scientist is intensely religious—he is so religious that he will not accept quarter-truths, because they are an insult to his faith. . . .
>
> He speaks no meaner of the ridiculous faith-healers and chiropractors than he does of the doctors that want to snatch our science before it is tested and rush around hoping they heal people, and spoiling all the clues with their footsteps. . . he hates pseudo-scientists, guess-scientists—like these psycho-analysts; and worse than

> those comic dream-scientists he hates the men that are allowed in a clean kingdom like biology but know only one text-book and how to lecture to nincompoops all so popular! He is the only real revolutionary, the authentic scientist, because he alone knows how liddle he knows. . . .
>
> But once again always remember that not all men who work at science are scientists. So few! The rest—secretaries, press-agents, camp-followers! To be a scientist is like being a Goethe: it is born in you. Sometimes I t'ink you have a liddle of it born in you. If you haf, there is only one t'ing—no, there is two t'ings you must do: work twice as hard as you can, and keep people from using you. I will try to protect you from Success. It is all I can do. So. . . . I should wish, Martin, that you will be very happy here. May Koch bless you![8]

In this speech, Gottlieb tells Arrowsmith what it means and what it takes to be a true scientist. One must be called to be a scientist; it is not merely a job that one does for a living, but lies at the core of his identity. In this way, science is similar to how virtues must become an integral piece of who the scientist is. The true scientist cannot imagine being anyone other than a scientist and those who profess to do science but have not integrated it into their identity are imposters. True scientists adhere to the most stringent standards for scientific research. They insist upon these rigorous criteria because they search for absolute, universal truth that can only be found through the most dedicated adherence to scientific methods. Because of these exacting standards, the true scientist's dedication to furthering science must be evidenced by his hard work, through the long hours spent in the lab, his disregard for popularity or money, his neglect of anything that he does not see as contributing to his work. However rigorous and well-executed an experiment may be, the scientist must remain ever-critical of his work. He must be unrelentingly skeptical of his experimental design, of his results, of his interpretation of those results. Only in this way will he be able to reach universal truth.

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[8] Lewis, *Arrowsmith*, 278-279.

Gottlieb warns Arrowsmith that there will be external forces that distract him from his work, but that Arrowsmith must ignore them and remain focused on his work. Those distractions will muddle the scientist's thinking and cause him to lose sight of his true mission. Although the McGurk Institute seems idyllic at first, the longer he is there, the more Arrowsmith realizes that even this supposedly safe haven of research cannot protect him from distractions, and is even sometimes the source of the distractions. When Arrowsmith stumbles across a potential cure for a deadly epidemic, he is celebrated and honored, but unable to dedicate himself as fully in the lab as he would like. As he becomes more recognized, he realizes this is the Success from which Gottlieb wanted to protect him. The novel culminates in Arrowsmith's rejection of everything that prevents him from doing research: his wife, his child, his position at the McGurk Institute and the administrative duties they want to give him, the polite society and dinner parties, everything. The novel closes with Arrowsmith sitting in a boat on a placid lake, telling his friend and like-minded scientist, "I feel as if I were really beginning to work now. . . This quinine stuff may prove pretty good. We'll plug along on it for two or three years, and maybe we'll get something permanent—and probably we'll fail!"[9] Arrowsmith's excitement about a research project that may take several years and likely end in failure shows he has finally become a true scientist whose dedication to the practice and quality of the work he does far outweighs any practical use his research may yield.

Lewis crafts Arrowsmith's eventual renunciation of material comforts as the pinnacle of his heroism. Arrowsmith's heroism stems from a series of self-sacrifices for

[9] Ibid., 450.

science; his complete dedication requires he reject every obstacle that prevents him from pursuing truth. This rejection entails renouncing everything that made him socially respectable, where his "transcendence emerges, paradoxically, through his descent from civilization. . . in Lewis's hands, however, civility becomes the thing that courageous men avoid. Civilization implies a range of attitudes and behaviors in the narrative: table manners, charity, polite language, compassion, concerns about personal cleanliness, and the acquisition of private property. Science entails a renunciation of them all."[10] In *Arrowsmith*, science is not a way to advance civilization, but instead works in opposition to civilization. The structures and rules of civilization are obstacles to finding scientific knowledge, and the true scientist must find a way to vanquish or avoid them. Charles Rosenberg describes Arrowsmith as "a hero not of deeds, but of the spirit. His scientific calling is not a concession to material values, but a means of overcoming them. In the austere world of pure science and in the example of Max Gottlieb, Arrowsmith finds a system of values which guide and sanction his stumbling quest for personal integrity."[11] Paradoxically, Arrowsmith's self-sacrifices do not transform him into a true scientist, but instead are necessary for him to retain his true self, maintain his integrity. His spirit was always that of a true scientist; the world and its concerns prevented him from realizing it earlier. He sacrifices a materially comfortable life for a life of the mind. However as a true scientist, the material comforts Arrowsmith gives up pale in comparison to what he gains, and likely would not seem to be sacrifices at all to Arrowsmith. Despite how Arrowsmith

[10] Herzig, *Suffering for Science*, 105.
[11] Rosenberg, "Martin Arrowsmith," 447.

benefits from rejecting civilization, his renunciation of a respectable, comfortable life to do science transforms him into a heroic scientist.

The first decades of the twentieth century were a fertile time for portrayals of heroic scientists. Soon after *Arrowsmith* was published, another popular book was published that presented science as a heroic enterprise, Paul de Kruif's *Microbe Hunters*.[12] Written in 1926 and republished in 1953 and 2002, *Microbe Hunters* is not a novel, but a historical tracing of the important men in bacteriology's history, presented in a series of vignettes that details their discoveries. From Antony van Leeuwenhoek in the seventeenth century to Paul Ehrlich in the early twentieth, each chapter chronicles each scientist's life and his contributions to bacteriology. Although the scientists vary in temperament and personality, de Kruif chronicles these scientists as embodying the true spirit of science through their passion and dedication to science, demonstrated in a variety of ways. He presents many notable scientists in bacteriology and virology, but I will only focus on two—Louis Pasteur and Walter Reed.

For bacteriology and virology, Louis Pasteur made many significant contributions, such as showing that microbes do not spontaneously generate, helping develop the germ theory of disease, and developing a vaccine against rabies. In relating these discoveries, de Kruif speaks of Pasteur in glowing terms, as a man so wholly dedicated to his work that his world narrows into whatever experimental question he presently faces. When discovering microbes as the cause of fermentation and some of its problems, de Kruif describes Pasteur

[12] Interestingly, in writing *Arrowsmith*, Lewis collaborated with de Kruif. De Kruif supplied Lewis with the details of the laboratory and the scientist characters, particularly the philosophy of Max Gottlieb, who was modeled on Jacques Loeb.

as "deaf and dumb and blind to the world of men; he stayed entranced before his little incubator; hours floated by, hours that might have been seconds for him. He took up his bottle caressingly; he shook it gently before the light. . . Now he would find out!"[13] Through the rest of the chapter, Pasteur is described in similar terms where Pasteur's obsession with understanding the microbes and their role in human life stands as a defining trait of the heroic scientist. And while he has a wife, children, and colleagues, they mostly fade into the background of his scientific work; Pasteur is characterized as the lone scientist toiling away in his lab, sustained only by the hope of discovering new knowledge.

However, Pasteur's heroism is cast as a different type of heroism than is represented by Gottlieb and Arrowsmith. Like the others, Pasteur is passionate about scientific knowledge, but he is also characterized as a fearless and showy adventurer. As his scientific accomplishments grew, he became "more than a man of science; he became of them a composer of epic searchings, a Ulysses of microbe hunters. . ."[14] Pasteur becomes characterized as an intrepid explorer, one who sets out to do what has never been done, a discoverer of the new and the unknown, where his domain of exploration is scientific knowledge. And as described by de Kruif, these characterizations are not merely thrust upon him, but also furthered by Pasteur: "These successes made Pasteur drunk with confidence in his method of experiment; he began to dream impossibly gaudy dreams. . . and he did more than brood alone over these dreams; he put them into speeches and preached them. He became, in a word, a new John the Baptist of the religion of the Germ

[13] Paul de Kruif, *The Microbe Hunters*, 3rd ed. (San Diego, CA: Harcourt, 1926), 65.
[14] Ibid., 81.

Theory. . ."[15] Exploration and promotion, for Pasteur, become a part of his greatness, resulting in a different type of hero from Gottlieb or Arrowsmith. While Gottlieb and Arrowsmith struggle to keep other people and ordinary concerns at bay so they would be free to pursue their research, Pasteur willfully engages with others to convince them of his work, to convert them to his work. While Pasteur does typify the lone investigator secluded away with his thoughts, he is also a vocal promoter of his ideas and his work, something that would be blasphemous to Gottlieb, but for Pasteur, is considered to be part of what makes him a great scientist. Not only has he furthered scientific knowledge, but he also works to spread that knowledge. Thus Pasteur in some ways is a very different type of heroic scientist than those previously discussed. Like the figure of the mad scientist, the figure of the heroic scientist has room for some variation, with his heroism exemplified in different ways.

Pasteur's self-sacrifice stemmed from his dedication to producing and disseminating science; he did not put himself in physical danger. The physical kind of heroic self-sacrifice can be seen through the Yellow Fever Commission. Yellow fever was a feared disease in many parts of the U.S., typically flaring up in the summer months, particularly in the coastal regions. By the end of the eighteenth century, outbreaks of yellow fever routinely befell port cities, wreaking havoc on their economies and filling its citizens with dread and anxiety. Regarding the devastation it wrought, Lawrence K. Altman notes that prior to the Yellow Fever Commission, "outbreaks of yellow fever had occurred in the United States at least ninety-five times over the preceding 208 years. . . usually killing one

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[15] Ibid., 87.

in five victims."[16] The high mortality rate resulted in strict quarantine measures for the affected cities. Headed by Walter Reed in 1900, the Yellow Fever Commission was composed of Reed, James Carroll, Jesse Lazear, and Aristides Agramonte. They were sent to Cuba, where yellow fever was endemic, to study the cause and prevention of yellow fever. Based on the work of Carlos Finlay, they theorized that yellow fever was transmitted by mosquitoes. However, yellow fever could not be induced in animals; only humans caught it. Thus, to test their hypothesis, they had to deliberately infect someone with yellow fever, knowing there was a significant likelihood it could result in death. Thus, the risks in studying yellow fever were high. The Commission decided that before they could test their hypothesis on anyone else, they had a moral obligation to first test it on themselves.

In relating the deeds of the Yellow Fever Commission, de Kruif attributes the decision to first self-experiment as mostly Reed's, describing him as "a blameless man, a Christian man, and a man—though he was mild—who was mad to help his fellow men."[17] Thus, Reed's heroism stems not from his pursuit of scientific truth, but instead from his desire to help his fellow man. Reed is portrayed as a man with a "strong moral nature," guided by his resolute commitment to finding the cause of yellow fever, which also helps him justify deliberately giving others yellow fever. Reed is an exemplar for others, both in morals and in spirit. Often in cases of self-experimentation, the Golden Rule—treat others they way you would like to be treated—is given as a moral reason. The investigators feel

[16] Lawrence K. Altman, *Who Goes First? The Story of Self-Experimentation in Medicine* (New York, NY: Random House, 1986), 130.

[17] de Kruif, *The Microbe Hunters*, 309.

they cannot conscionably ask others to take risks that they do not willingly first undertake themselves.[18]

De Kruif places the decision and reasoning for self-experimentation with Reed, who tells his colleagues, "'If the members of the Commission take the risk first—if they let themselves be bitten by mosquitoes that have fed on yellow fever cases, that will set an example to the American soldiers, and then—' Reed looked at Lazear, and then at James Carroll."[19] De Kruif relates both Carroll and Lazear as unhesitatingly assenting to self-experiment. Doing self-experimentation before asking for volunteers was a moral imperative and set an example for later volunteers, which then could serve as a recruiting tool or a way to boost confidence in the experimenters' capacities. Thus the heroic self-sacrifice of the Commission is very literal—they risked their bodies and lives in hopes of finding useful results. And with the self-experimentation they began to collect evidence that yellow fever is only caused by mosquitoes. However, only two of the four members of the Commission actually self-experimented, Carroll and Lazear. Agramonte was thought to possibly have already developed immunity and Reed left Cuba days after they agreed to self-experiment. Both Carroll and Lazear contracted yellow fever, with Carroll becoming

[18] The Golden Rule reason for self-experimentation is a compelling one, but it should be noted that self-experimentation actually uses a variation of the Golden Rule. Instead of "treat others the way you would like to be treated," the moral thrust becomes something more like "first treat yourself the way you would like to treat others." If the Golden Rule were followed exactly, very little experimentation on humans would happen for presumably most people, including investigators, would not want to be on the receiving end of someone else's untested intervention. Thus, if they strictly adhered to the Golden Rule, they should not experiment on others if they had any reservations about experimenting on themselves. The investigators who cite the Golden Rule as their reason for self-experimentation are often hesitant to experiment on others. But this hesitancy is overcome after choosing to subject themselves to the treatment before asking others. The reason to subject one's self to an experiment before asking another to undertake it is legitimate and admirable, but it is not strictly the Golden Rule.

[19] de Kruif, *The Microbe Hunters*, 309.

very ill but eventually recovering and Lazear eventually succumbing to the disease. While their actions provided good evidence for the theory of mosquito transmission, the Commission needed additional evidence and called for volunteers, which I will further discussion in the next section of this chapter.

In contrast to Arrowsmith and Gottlieb, the members of the Commission are heroes of deeds, if not spirit. While they relied upon sound scientific evidence, their ultimate purpose was to find the cause of yellow fever. Like the mad scientists, heroic scientists can vary, in seemingly contradictory ways. Some scientists' heroism finds its foundation in the pursuit of pure scientific knowledge, while others are motivated by practical applications of science for the benefit of many. And some, like Pasteur, draw from both. However, all heroic scientists must have admirable motivations for doing science and be wholly committed to science, evidenced by the sacrifices they make. The images of these scientists are constructed in a specific way to show science in a flattering light. However, like the image of the mad scientist, it is quite skewed depending upon its purposes. Close examination of the heroic scientist is necessary to see how it is constructed, specifically with an eye towards what is left out or misrepresented.

Reading the Heroic Scientist

Perhaps more than the other figures discussed, these heroic historical and literary accounts of scientific practice necessitate a careful reading of the texts that keeps in mind how this particular account is constructed. As with the other figures of scientists, the purpose of the heroic figure is clear. The mad scientist warns about the perils of an out-of-control, unreflective, unchecked science; the ordinary scientist demonstrates how science is a human activity like any other; and the heroic scientist celebrates and glorifies the accomplishments of science. However, to an extent, the purpose of the mad and ordinary figures is to point out the flaws in scientific practice, while the heroic figure tends to ignore them. Thus, accounts of heroic scientists must be read with careful attention paid towards what is left out in these constructions that then allows the scientists and their deeds to be considered heroic. As previously mentioned, the time of *Arrowsmith* and *Microbe Hunters* was particularly rife with faith that science could yield solutions to the suffering and misery disease caused. De Kruif's *Microbe Hunters* and his contribution to *Arrowsmith* are examples of this belief. About *Microbe Hunters*, William Summers describes de Kruif as "convinced of in [*sic*] the power of science to solve health problems, and of the public health message that militant attacks on germs would conquer infectious diseases. He wrote with the fervor of a talented and enthusiastic true believer."[20] Although Lewis' and de Kruif's works are well-researched and provide a reasonable starting point for understanding the accomplishments and bacteriologists and virologists, they are also hagiographic with a clear intention of celebrating the heroic ideal of the scientist. While those triumphs certainly are admirable and should be recognized, they should also be understood alongside the setbacks and ethical transgressions of bacteriology and virology, which the heroic accounts tend to ignore. A close reading of heroic scientists entails a critical examination of the text to discern how the authors construct the image and what the authors are not including.

[20] William C. Summers, "Microbe Hunters Revisited," *International Microbiology* 1, no. 1 (March 1998): 66.

Arrowsmith traces Martin Arrowsmith's transformation into a heroic, self-sacrificing scientist, which is demonstrated in his rejection of the restraints of civilization and retreat to the wilderness to continue his work unimpeded. Lewis presents Arrowsmith as undoubtedly heroic as he comes to fully embrace science's values and methods, which culminates in his rejection of civilization. However, this heroic characterization of the scientist tends to overshadow the ethical issues the scientist encounters in his work. As previously mentioned, Arrowsmith stumbles across a potential cure for a disease plagues the West Indies. The McGurk Institute sends him there to test his cure in the population where he should give only half the population the cure, leaving the other half as a control group. Arrowsmith leaves for the West Indies with his wife and an assistant and experiences the devastation of the plague first hand. However, the novel glosses over the ethical issues of this research plan. Nothing is mentioned about what the West Indies government or people are told of the research plan, if anything, and there is no evidence that they tell the people of the experiment once they are there. Although physicians in the West Indies initially contacted Gottlieb for assistance, it is unclear how Arrowsmith and his assistant explain their presence in the West Indies to the people there. This lack of (or at least ambiguity about) disclosure to the West Indies people about their role as test subjects is troubling. Although this criticism may be unfair from today's standpoint on research ethics, which places substantial emphasis on disclosure and informed consent, attention to these oversights highlights what Lewis omits in constructing Arrowsmith as a heroic scientist.

And the fairness of the research plan is questionable. How fair is it to withhold a potential treatment from a population suffering from a deadly plague? Should rigid adherence to the scientific method be upheld in the situation? Arrowsmith tries to stay true to the original plan, even though he is overwhelmed by the ravages of the plague. In staying with the plan, he tries "to recall the vision of Gottlieb and all their little plans: 'half to get the phage, half to be sternly deprived.' It came to him that Gottlieb, in his secluded innocence, had not realized what it meant to gain leave to experiment amid the hysteria of an epidemic."[21] Once there, Arrowsmith realizes how difficult the most well-laid out research plan in the lab may be to implement. He realizes the cruelty inherent in their research plan. But he stays with the research plan, until his beloved wife accidentally falls ill and dies from the plague. After she dies, he no longer cares for his research and gives the treatment to everybody, compromising his experiments and results. When he returns back home, Arrowsmith is celebrated as a hero for the success of his cure. Arrowsmith's deviation from the research plan is discussed only insofar as how Arrowsmith tries to confess his betrayal of science to Gottlieb, seeking absolution. However, by his return, Gottlieb has dementia and no longer recognizes Arrowsmith. Nothing is made of how Arrowsmith's giving the cure to everyone at the end affects the results they obtain. While it is unclear that giving the cure to everybody affected their results or if it was factored into their final analysis, this complication is unexplained and largely ignored.

The novel pays little attention to the ethical questions of Arrowsmith's work, largely glossing over them instead. It fails to explore what Arrowsmith's adherence to his

[21] Lewis, *Arrowsmith*, 374-375.

experiment and subsequent break down could mean for the people of the West Indies and the public at large.[22] Arguably, discussing these questions at length complicates Lewis' construction of the heroic scientist, as the heroic scientist is expected to remain focused on the scientific questions at hand and the ethical questions would simply detract the scientist from his work. However, in examining the heroic scientist, the real world scientist should pay close attention to the ethical questions that are a part of scientific practice. While they are often ignored in the depictions of the heroic scientist, they can serve as launching points for the real world scientist to explore these issues. Although the novel itself does not create space to deliberate the ethical issues, they are still present and open to discussion. The heroic scientist's failure to attend to his work's the ethical questions also calls attention for the reader to examine how the heroic scientist is constructed, such as looking at how the character's specific features, such as the scientist's dedication and attempts for objectivity, that define his heroism, may also lead to his failure to see the consequences of those features and how the heroic image hinges on the author's sidestepping the trickier ethical questions. However, by remaining aware of how the heroic scientist is constructed and what may be overlooked in the process, the reader can still use the novel as a way of discussing the ethical questions that are a part of science.

Constructions of heroic scientists and the necessary omissions are not limited to fictional scientists, but are also at work when presenting an actual scientist and his

[22] While Arrowsmith's decision to give everybody the phage could be interpreted as an ethical epiphany, it was more of an impulse than a one backed by moral reasons. His sudden reversal of the plan results from his disgust with himself and science. Lewis explains, "Because death had for the first time been brought to him, he raged, 'Oh damn experimentation!' and. . . he gave the phage to everyone who asked" (p. 392). Arrowsmith does not break from the experiment because he thought everybody should be given it, but because of his overwhelming grief and anger over his wife's death.

accomplishments as heroic. One of the most celebrated scientists is Pasteur for his work in the germ theory of disease and vaccine development. Pasteur undoubtedly contributed much to bacteriology and virology. However, characterizations of him as a heroic scientist should be more closely examined to see what features of actual science are eschewed when building that image. Through his heroic account of Pasteur, de Kruif presents a simplified view of science, one where knowledge is discovered in a series of eureka moments after endless nights of toil in the lab and where the heroic scientist stands as the bearer of truth. While de Kruif depicts Pasteur's curiosity well, any uncertainty Pasteur might have had in the face of ambiguous or unexpected results that contradict widely held beliefs falls into the background. In discovering that microbes cause food to spoil, Pasteur realizes that some of them can live without air. In describing this incident, de Kruif writes, "He was peering, one day, at the rancid butter microbes swarming before his microscope. 'There's something new here—in the middle of the drop they are lively, going every which way.' Gently, precisely, a little aimlessly, he moved the specimen so that the edge of the drop was under his lens... 'But here at the edge they're not moving, they're lying round stiff as pokers.' It was so with every specimen he looked at. 'Air kills them,' he cried, and was sure he had made a great discovery."[23] Pasteur's realization that some microbes cannot live in the presence of air is presented as straightforward and conclusive. It lacks the uncertainty and doubt of one's self and results that often pervades science and, instead, collapses periods of time making the discovery seem linear and seamless. De Kruif's construction of Pasteur's discoveries as relatively straightforward and without much uncertainty contributes to

[23] de Kruif, *The Microbe Hunters*, 72.

Pasteur's image as a great and heroic scientist, but is not an accurate account of scientific practice.

As previously mentioned, Pasteur was a showman for science. He vocally promoted his ideas and his discoveries, which de Kruif describes in glowing terms. One of the most notable examples of Pasteur blending science and showmanship is the anthrax vaccine trials at Pouilly-le-Fort from May to June 1881. After Pasteur discovered animals could develop immunity to a disease from attenuated bacteria, he arranged a public demonstration to show it. Over a series of weeks, he induced immunity to anthrax in sheep, some cows, and a goat by giving them injections of increasing virulence. To show the animals' immunity, he then inoculated vaccinated group and another group of animals who had not previously received anything with a lethal dose of anthrax. None of the animals who had received the prior injections of attenuated virus developed anthrax, while most of those in the other group fell ill and died.[24] This episode is considered one of Pasteur's greatest successes in demonstrating the validity and usefulness of scientific knowledge in daily life, and soon had many farmers asking to use his vaccine. De Kruif presents this episode as a tense and anxious time for Pasteur and his lab: "The time for the fatal final test drew near; the very air of the little laboratory became finicky; the taut workers snapped at each other across the Bunsen flames. Pasteur was never so appallingly quiet—and the bottle washers fairly jumped across the room to fill his growled orders."[25] Much was riding on the success of this experiment, not least of all his reputation and the credibility of his work. However,

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[24] Louis Pasteur, "Summary Report of the Experiments Conducted at Pouilly-Le-Fort, near Melun, on the Anthrax Vaccination," *Yale Journal of Biology and Medicine* 75, no. 1 (January-February 2002): 61.

[25] de Kruif, *The Microbe Hunters*, 155.

despite the tension, Pasteur is also presented as fairly confident in the success of the experiment, despite the worries of his assistants. This characterization creates a Pasteur with an appropriate blend of boldness and reservation. He becomes someone who is bold enough to advocate for science's practical uses, but not to the point of hubris. And he has enough self-doubt to retain his qualities as a true scientist, someone who continually reexamines and questions his work, and is not just a showman. With these characteristics, de Kruif constructs Pasteur as an admirable symbol for science, representing both the seemingly opposing sides of science for practical application and science for truth.

However, to construct the Pouilly-le-Fort episode as an unequivocal success, a few details needed to be ignored. It was presented as an experiment, giving the public the impression that it had an uncertain outcome, as a way of convincing doubters of the validity of vaccines. However, Bruno Latour points out that it was not so much an experiment, as it was a demonstration in the guise of an experiment. It is not an experiment with uncertain results, but "the public showing of what has been rehearsed many times before in his laboratory. It is strictly speaking a repetition, but this time in front of an assembled public which has previously invested so much interest and is now expecting its rewards."[26] The bulk of testing the attenuation process had already happened in the months before the demonstration, where Pasteur and his assistants worked out the necessary technical details, such as the best method to attenuate the virus and the appropriate time intervals for the injections. And indeed those technical details are not as

[26] Bruno Latour, "Give Me a Laboratory and I Will Raise the World," in *Science Observed: Perspectives on the Social Study of Science*, ed. Karin D. Knorr-Cetina and Michael Mulkay (London, UK: SAGE Publications, 1983), 151.

straightforward as Pasteur reported. Regarding the methods used to attenuate the virus, Gerald Geison has noted contradictions between Pasteur's private lab notebooks and what he reported to the public. The Pouilly-le-Fort demonstration had already been scheduled, but Pasteur was still working on developing attenuation methods. Two possible methods were in contention, one using oxygen and using potassium-bichromate. Pasteur preferred the oxygen method and claimed it was superior to the other method, since using potassium-bichcromate was too similar to a competitor's method. Pasteur tested both and after the success of the demonstration, reported he used the oxygen attenuation method. However, Geison's inspection of Pasteur's lab notebooks reveals Pasteur's uncertainty about the oxygen method, and that he instead chose to attenuate the virus using the potassium-bichromate method because the data for that method was more secure, even though he publically supported the oxygen attenuation method.[27]

Pouilly-le-Fort was more like a rehearsed demonstration, whose outcome was pretty much known to Pasteur. And it was a success—the vaccinated animals lived and Pasteur showed the efficacy of vaccines. However, this success relied upon a few deceptions that helped ensure Pasteur's reputation would emerge intact and unblemished. Although he could not be absolutely certain of its success, he was confident enough to stake his reputation on the outcome of this very public demonstration. But to better ensure its success, he chose the method that would more likely secure it. However, to preserve his reputation, he credited the method he had already vocally supported. And the demonstration was presented as an experiment with an uncertain outcome, although

[27] Gerald L. Geison, *The Private Science of Louis Pasteur* (Princeton, NJ: Princeton University Press, 1995), 151, 70-71.

Pasteur was fairly certain that it would succeed. These details of the demonstration were largely ignored in constructing Pasteur as a heroic image; they would have significantly detracted from that message. The way de Kruif presents Pasteur and the events at Pouilly-le-Fort differs significantly from the other interpretations of the same events. And although it would be unfair to accuse de Kruif of ignoring the factual details that these other interpretations use, for Geison used material that was not available until decades after the publication of *The Microbe Hunters*, the heroic construction of Pasteur depends upon highlighting how he admirably personified science's values.

Like the heroic presentations of Arrowsmith and Pasteur, the heroic constructions of Walter Reed and the Yellow Fever Commission are similarly simplified and flawed. In describing the Commission's decision to self-experiment, de Kruif presents it as straightforward and unhesitating. Reed presents the idea, and Carroll and Lazear immediately agree. However, other accounts describe the decision as somewhat more complex. Altman argues none were particularly enthusiastic about self-experimenting with a method that may give them yellow fever. But they agreed based on both moral and practical reasons, that they must be the first ones to assume the risk and it would be very difficult to find appropriate test subjects. Additionally, in later years, Carroll maintained that he had originally raised the idea of self-experimentation twice before Reed first raised it at that meeting.[28] While these may be unnecessary details, their exclusion helps construct an uncomplicated, heroic narrative of the Commission, particularly of Reed. Problems of dissent and uncertainty become negligible details, creating a picture of science

[28] Altman, *Who Goes First?*, 142-143.

that is unerringly self-assured and moral. With this type of construction of science, scientific practice becomes a linear series of successes that further human progress without the multitude of obstacles that often impede understanding and acceptance of science. Possibly, Altman had more access to the historical record than de Kruif or more details had been uncovered in the time between de Kruif's writing and Altman's. However, prudence and reasoning would indicate that the Commission would be reluctant to deliberately contract yellow fever and de Kruif makes no concessions for this possibility. The lost details are important in creating a more realistic version of science that does not uncritically praise scientists.

Somewhat more significant, as Walter Reed is often remembered as the main hero of the Yellow Fever Commission, is de Kruif's explanation of why Reed abruptly left Cuba days they agreed to self-experiment. De Kruif notes, in a parenthetical aside, "he had been called home to Washington to make a report on work done in the Spanish War."[29] However, the historical record is not clear as to why Reed left, if it was for his work previously done on typhoid, although there is no evidence that was the reason. In his official summary, he records he was on duty as curator of the Army Medical Museum, a position he held since 1893 and used for routine travel to Washington. However, he did not cite the specific orders that called him to Washington, although he usually did in reports that detailed his travels between Cuba and the United States.[30] It is not clear if Reed was summoned to Washington or if he left Cuba voluntarily. Presenting Reed's absence as straightforward and out of his control, instead of ambiguous and possibly

[29] de Kruif, *The Microbe Hunters*, 309.
[30] Altman, *Who Goes First?*, 143-144.

voluntary, excuses his absence and preserves the heroic image. Allowing for any ambiguity surrounding his reason would significantly detract from de Kruif's construction of Reed as a fearless, heroic leader. Again, perhaps de Kruif did not have access to the historical record to the extent that Altman did. However, by only mentioning the reason for Reed's absence in a parenthetical aside allows de Kruif to present it as insignificant, preserving the Reed's heroic image.

The Commission's later recruitment of volunteers presents additional ethical questions. Although they had solid evidence supporting the theory that mosquitoes transmitted yellow fever, they needed to run additional experiments with other human subjects. They devised three different types of experiments that involved bites from infected mosquitoes, injection of blood from yellow fever patients in the early stages of their illness, and intimate contact with the patients' clothing, bedding and other fomites that were thought to transmit the disease.[31] They recruited American soldiers stationed in Cuba and recent immigrants from Spain. To those who volunteered, they offered between one to three hundred dollars, with at least some of it to be paid in gold. With these volunteers, the Commission provided possibly the first example of a documented informed consent process for experimentation on human subjects. At least some of the volunteers were required to sign a document that confirmed they were "in the enjoyment and exercise of [their] very own free will" and consented to the yellow fever experiments by the Commission."[32]

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[31] Ibid., 151.

[32] "Informed Consent," *Otis Historical Archives, National Museum of Health & Medicine*, accessed September 7, 2012, http://www.flickr.com/photos/medicalmuseum/5094363976/sizes/l/in/photostream.

In several ways, the document is useful for giving us insight into how the Commission tried to navigate the difficult moral waters of human experimentation. But it is also significant for what it focuses on and what it excludes. Written in both Spanish and English, the document makes provisions for the care of the volunteer if he does contract yellow fever, and that he will receive one hundred dollars in gold for his participation, with the possibility of another one hundred in the event of his death from the experiment. These provisions underscore the Commission's recognition that they owe the volunteer something for assuming this significant risk, that this kind of service places them in a type of debt to the volunteer, to be paid with medical care and gold. However, the structure and framing of the consent form is somewhat troubling. While the form requires the volunteer to affirm he understands he places his life at risk, but since "it being entirely impossible for him to avoid the infection during his stay on the island, he prefers to take the chance of contracting it intentionally in the belief that he will receive from the said Commission the greatest care and the most skillful medical service."[33] The disease is presented as inevitable, but at least in the case of infection through experimentation, good medical care is promised. This presents volunteering for the experimentation as a reasonable option and a way to get medical care, since they are highly likely to contract the disease regardless of their participation.

Additionally, the sum of at least one hundred dollars in gold can be a considerable incentive to participate, regardless of the risks. Altman speculates that this considerable

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[33] Ibid.

sum is why some of those not chosen nearly wept.[34] Unfortunately, the document does not mention how thorough the experimenters were in discussing the study and its possible consequences, making it difficult to determine if the volunteers were truly informed and wanted to participate despite the risks, or if they were swayed to participate because of the money, compounded with the inevitableness of the disease and promise of good medical care. While the document provides a record of some sort of consent process, it also raises questions about what the consent process was like and if the volunteers wanted to participate despite the risks, or if they were influenced by how the researchers framed the disease and the study. Critiquing their consent process from today's vantage point that has more established rules governing the informed consent process may be unfair. However, looking at past examples of past problems in informed consent, and other research ethics issues in general, and how they were mishandled can help us better locate our own ideas about what a good informed consent process would entail.

In presenting Gottlieb, Arrowsmith, Pasteur, or Walter Reed and the Yellow Fever Commission as exemplars of the ideal scientist who glorify very specific values of science, this construction of the heroic scientist may initially appear to inhabit the opposite side of the spectrum from the mad scientist. The mad scientist is irresponsible, callous, hyperrational, and obsessed with his work despite the consequences, while the heroic scientist is self-sacrificing, passionate, methodical, and painstakingly precise. The mad scientist is presented as an evil, or at least a deeply suspect character, while the heroic scientist presented as a good, admirable figure. However, upon closer inspection the two

[34] Altman, *Who Goes First?*, 151.

are not diametric opposites, but instead resemble something closer to opposite sides of the same coin. They share significant similarities, but those similarities are presented differently depending upon the author's purpose. For example, both mad and heroic scientists value objectivity. For the mad scientist, this objectivity is how the author illustrates this character's callousness and indifference to the consequences of his work. Indeed, some mad scientists argue that consideration of the consequences and other ethical issues do not fall within the realm of scientific practice since it is not objective. In failing to care about the consequences of his work for others, his objectivity leads him to commit a variety of ethical transgressions. However, for the heroic scientist, the author presents his pursuit of objectivity as necessary to maintain fidelity to the scientific method. And fidelity to the scientific method is the path towards finding truth, which is the ultimate good in an idealized science.

Similarly, both mad and heroic scientists dedicate their life to science, to the exclusion of significant personal relationships. They lead isolated lives centered around science. For mad scientists, this obsession blinds them to considering the consequences of their work. Their world narrows to solving the problem at hand, without pausing to consider how their work may affect themselves or others. And their isolation allows them to conduct their objectionable experiments out of the public eye, giving them the freedom to commit ethical transgressions unfettered. For heroic scientists, however, obsession is more often reinterpreted as passion and dedication in the name of scientific truth. Thus, their narrowing of focus and concerns are attributed to their pursuit of truth, presented as a laudable goal that excuses their narrowed vision. And their isolation becomes a necessary precondition for finding truth; it relieves them of the multiplicity of obstacles that distract them from their goal. Part of their heroism stems from this narrowing and isolation, which can be seen as a type of self-sacrifice, by giving up the desires of the ordinary man. For the heroic scientist, their extreme focus on their work allows them to transcend ordinary cares.

Thus in some ways, the heroic scientist and the mad scientist are more similar than they are different, sharing the same characteristics that are presented very differently. However, they do differ in important ways, notably in their motivations and their intentions, or at least the way their intentions and motivations are presented. The mad scientist's reasons for his work are often muddled, deemphasized, or simply reprehensible. Some mad scientists work to destroy humanity, such as Crake, while other mad scientists' motivations are less clear. Victor Frankenstein's motivation for creating the Creature is initially driven by his curiosity, but his work soon takes on a life of its own (literally, eventually) that overshadows his original reasons. Dr. Moreau's reasons for vivisection are somewhat unclear. Although he explains he is driven by scientific curiosity with vague ideas about understanding more about pain, the reader is not quite sure to what end. The narrator even describes Moreau's experiments as "aimless." In contrast, heroic scientists' motivations and intentions are perfectly clear, which are usually finding scientific truth or benefiting the public with their discoveries. Their reasons are prominently displayed. Gottlieb and Arrowsmith are striving towards finding scientific, universal truth and Arrowsmith orders his life in a way that allows him to reach this goal, by eventually rejecting civilization. The Yellow Fever Commission is explicitly formed to find the cause of yellow fever and all of their actions presented in *The Microbe Hunters* are critical to accomplishing their goal. Any extraneous actions that do not contribute to finding the cause of yellow fever are omitted. And Pasteur in *The Microbe Hunters* holds both goals, working to both find scientific truth and help the public.

For both heroic and mad scientists, which ever category one falls into is based in part on his intentions and motivations, or lack of for some mad scientists and how their scientific values are presented. Although their motivations may bear some similarities, such as curiosity as a driving force for both figures, the author's construction of the characteristic determines into which category the character falls. In examining Arrowsmith and Gottlieb, their construction as heroic, ideal scientists bears considerable similarities with the mad scientist. To illustrate, as the mad scientist is often a mysterious, shadowy figure, Gottlib at least initially to Arrowsmith, is also shrouded in mystery. However, instead of being sinister, the Gottlieb's mysteriousness further compels Arrowsmith to pursue science. Similarly, while the mad scientist is often characterized as a solitary figure, single-minded in his pursuit of scientific knowledge, *Arrowsmith* in a sense, is the story of a man striving to become that solitary figure, freed from the mundane obstacles of daily life and able to single-mindedly pursue scientific knowledge. Gottlieb, more or less, has already achieved those and stands as Arrowsmith's exemplar. Where Arrowsmith's solitude is triumphant, in the mad scientist, it shrouds his suspicious activities. The mad scientist's obsessive pursuit of science becomes part of his madness and blinds him to seeing the various consequences of his work. For some mad scientists, it is this obsession that feeds into their characterization as hyperrational and emotionally detached, indifferent towards the suffering their work inflicts. This obsession is constructed as a decidedly negative trait.

In contrast, for both Arrowsmith and Gottlieb, instead of detracting from their heroic status, their commitment to unmitigated scientific knowledge becomes testaments to their worthiness as heroic scientists; their obsession with science contributes to their heroic image. However, their obsession does not render them completely unfeeling and hyperrational; both feel scientific and personal losses and triumphs acutely. Perhaps their capacity to emotionally feel and react, humanizes them and helps prevent their obsession from turning into a negative trait. The mad and the heroic scientists share important characteristics, characteristics which are at the foundation of their identities as scientists. The reader should remain aware that their constructions as either heroic or mad are determined by what messages about science the author intends to illustrate.

Conclusion

Although the image of the heroic scientist has changed since Sinclair Lewis's and Paul de Kruif's time, it remains pervasive today. The scientists are not so glowingly constructed, but are instead shaped more like ordinary people with ordinary pressures and cares. However, these characters are still more positive than negative. In popular television shows, such as the *Law and Order* series and other crime solving, detective shows rely upon results from medical science, such as DNA tests, which constitute critical and indisputable evidence. While the medical scientists in these shows are often minor characters, they play a key role in helping the detectives secure the necessary indisputable evidence for a conviction. Others have scientists as the main characters, such as the show *Bones*. In this crime-solving show, the main character and her team rely upon scientific methods as the way to solve the crime. Although the characters themselves have their own flaws and idiosyncrasies, collectively they promote the power of science for knowledge and to good for the world. And, in a sense, that is the purpose of the heroic scientist. By commemorating his deeds and accomplishments, science's position as a source of authoritative knowledge is further secured. The heroic narratives of scientists are effective in reinforcing the idea that progress advances through science. And although those narratives today are a bit more tempered than they were in the first half of the twentieth century, science is still largely seen as the most authoritative source of knowledge about human beings and the world.

As the image of the heroic scientist helps situate science within society, but also problematic regarding how it should be practiced, reading the heroic scientist requires careful attention to how that image is put together. While the image of the mad scientist intentionally portrays science in an unflattering light, it asks the reader to wonder about the dangers and problems of science. However, the heroic image tends to obscure what complicates or detracts from its positive message. It is unrealistic in many respects to the actual practice of science, but could still be useful for the real world scientist. The heroic scientist is a part of the general conception of scientists, replete with misunderstandings about what science can tell us. Part of what the heroic image does is put forth an unrealistic picture of how science is practiced. Much of the uncertainty, hesitancy, and contradictory theories that are a part of scientific practice are obscured in constructing a heroic scientist, resulting in an unrealistic conception of scientific practice. Examining this image and how it is constructed can help the real world scientist better understand how those misconceptions are perpetuated. Understanding what underlies these misconceptions can enable the real world scientist to be better equipped to respond in a way that addresses them when confronted by them.

Looking closely at how the heroic scientist is constructed can help the real-world scientist develop her capacity to see how various images and metaphors within science in general are constructed and how they function within that space. It allows her to see why, at least from a historical and literary perspective, science has taken the shape that it does and helps her situate herself and her practice within it. The various images and metaphors of science influence both public understanding of science and the shape of scientific practice, and understanding what goes into constructing them enables the real world scientist to shape her practice of science with an awareness of them and to decide if she would like to contribute to them or not. By being able to see the various facets of science and what they entail helps the real world scientist understand science in a fuller sense, in a way that helps her cultivate *phronêsis*. Similar to how studying the mad scientist can help the real-world scientist understand what informs her work's context and its relationship with society, the figure of the heroic scientist can deepen the real-world scientist's understanding of the hopes the public has placed in science. It further informs her own practice of science by illustrating how practicing science well is, in part, determined by her motivations, intentions, and values. In many cases, the heroic scientist's motivations separated him from the mad scientist. And while neither are particularly exemplary figures to emulate, the distinction shows the importance of one's motivations and intentions when evaluating science.

Taken together, how do the figures of the ordinary, the mad, and the heroic scientist help the real-world scientist craft a science that attends to its social and moral contexts? Each figure illuminates different features of science's larger context, that, when viewed together, provides a multidimensional perspective of science's complex relationship with society, where fears about science are held in tension with faith in what benefits it may bring. By teasing apart these conflicting views of science, the scientist can develop a more nuanced understanding of the public's stance towards their work. And all of these figures highlight the central role of the scientist's character in their work's scientific merit and ethical and social acceptability. The ordinary scientist shows how one's habits of mind and unexamined biases and assumptions can direct how one practices science. The mad scientist illustrates how the lack of reflection on his work's consequences or outright disregard of those consequences is precisely what makes science mad. And the heroic scientist shows how the mad scientist's negative traits can be turned into the scientist's best features, transformed through the character's (and author's) intentions, motivations, and purposes. However, the real-world scientist must keep in mind that the heroic scientist is heroic not because he embodies science's values and takes pains to avoid ethical transgressions, but that whatever ethical transgressions he commits are left out of his heroic construction. Despite the differences between the figures, they all underscore the need to cultivate a character that places high value on producing sound scientific knowledge that is attentive to its ethical and social dimensions.

Chapter 7: Conclusion: Bringing the Humanities into the Practice of Science and Training the Translational Scientist

The science of today is not the science of fifty years ago, and it is certainly not the science of Boyle and his seventeenth-century peers. Over the centuries, science has transformed from a loosely organized group of gentleman-scientists fighting for science's legitimacy in explaining natural phenomena to a highly structured global community functioning as a hugely influential source of authoritative knowledge. Its domain has expanded to include multitudes of specialties and subspecialties, such as biophysics, virology, molecular biology, and genomics in the biomedical sciences. Many of those areas of biomedical science have become part of its core identity, further spawning new burgeoning fields for today, including genetic engineering, synthetic biology, and nanotechnology. Alongside the new areas of science, other changes in the way science is practiced, in its structure, in its relationships with society are emerging. The past several decades have witnessed the shifting of science from academia to industry, academic institutions' accommodations and encouragement of investigators' potentially profitable lines of research, and an increasing demand for accountability and tangible benefits by the public.

What might science's future entail and is there space for the humanities in it? This concluding chapter discusses some features of translational science, a federally funded initiative that has been gaining momentum for the past several years. Translational science and its goals reconfigure science as it has traditionally been practiced. Its changes have the potential to alter science at a widespread level, which includes understanding science's contexts as part of practicing translational science. I also discuss efforts to bring ethical considerations into science through the required Responsible Conduct of Research courses and highlight some recent deliberations that use sources from the humanities to contextualize science. These efforts are a promising step towards incorporating science's context into the practice of science. I then sketch what a humanities-informed training program for the translational scientist might include. This type of program is useful because it can both inform science's contexts and help the translational scientist develop the skills necessary to construct and make sense of those contexts.

Features of Translational Science

When viewing the future of science from a financial perspective, a retrospective glance shows American science has grown and expanded considerably since the beginning of the twentieth century, and continues, although its pace has lessened considerably in recent years. The largest source of federal funding for biomedical science, both basic and clinical research, is the National Institutes of Health (NIH), which awards grants to thousands of scientists at various universities around the country. In 2010, it had a budget of nearly thirty-one billion dollars, the vast majority of which was used to fund research. The 2010 budget was the largest ever for the NIH, but in more closely examining the numbers in the history of NIH funding, the NIH budget (in raw dollar amounts, not accounting for inflation or other economy fluctuations over the years) has grown nearly every year since 1938. For some years, the budget doubled or more, while in other years, the budget saw only incremental advances. But every year, except for 1942, up to 2010, the NIH's budget expanded.[1] Then in 2011, the NIH's budget decreased, with the budgetary cuts distributed across each division. And while the overall budget further decreased in 2012, that decrease is partially attributable to the dismantling of the NIH's most well-funded division, the National Center for Research Resources (NCRR).[2] However, part of that dismantling entailed the creation of the National Center for Advancing Translational Sciences (NCATS).

Now housed within the NCATS is the Clinical and Translational Science Awards (CTSA), the largest project funded by the NCRR before it was dismantled. As the NCATS is the newest division of the NIH, its creation is indicative of developing trends in science. Examining the purpose and goals of the CTSA can give us an idea of science's future might look like. Beginning in 2006, these awards were given to various research institutions across the country "to speed the translation of laboratory discoveries into treatments for patients, to engage communities in clinical research efforts, and to train a new generation of clinical and translational researchers."[3] To realize this vision, the CTSA explicitly emphasizes "develop[ing] teams of investigators from various fields of research who can take scientific discoveries in the laboratory and turn them into treatments and strategies for patients in the clinic."[4] This vision of science places high value on teams

[1] National Institutes of Health, "History of NIH Appropriations," *U.S. Department of Health and Human Services*, last modified March 6, 2012, accessed August 22, 2012, http://www.nih.gov/about/almanac/appropriations/index.htm, http://www.nih.gov/about/almanac/appropriations/part2.htm.

[2] Funding for all the other divisions within the NIH increased during 2012, just not enough to make up the difference between the NCRR's 2011 funding and the NCATS's 2012 funding.

[3] National Center for Research Resources, "NCRR Fact Sheet: Clinical and Translational Science Awards," *National Institutes of Health, U.S. Department of Health and Human Services*, accessed May 31, 2012, http://www.ncrr.nih.gov/publications/pdf/ctsa_factsheet.pdf.

[4] Ibid.

whose members hail from a variety of disciplines, on productive communication and cooperation within those teams, and on efficiently moving knowledge from "the bench to the bedside."

In significant ways, for better or for worse, translational science reconfigures science as it is more typically practiced, particularly for basic scientists. In emphasizing efficiency as a defining characteristic, translational science works to place knowledge generated in the labs on a streamlined and straightforward path of useful therapies and technologies. This is not a particularly new phenomenon. Basic scientists often include discussions of their work's potential applicability in grant proposals. But there is no guarantee. The CTSA's explicit focus on this feature pressures translational scientists to produce knowledge whose applicability in developing treatments or technologies is readily apparent. From one perspective, this focus on practical application rests on the demand to not waste the resources that are given, particularly in these trying economic times. The streamlined path to utility is an attempt to more quickly move potential basic science results to clinical trials to therapies for patients, as promising basic science findings sometimes languish in the lab. This approach is considerably different from how science is typically practiced, particularly on the basic science end, where scientists have a pretty free rein in choosing what project to pursue that is generally irrespective of its potential uses. However, the early CTSA institutions have already encountered several obstacles that may hinder its pursuit of efficiency, such as lack of qualified investigators and mentors, high funding costs, fragmented infrastructure, and the academic reward system and career disincentives.[5] The push for efficiency could alter the way scientists practice science, possibly by prompting scientists to choose lines of inquiry whose potential fruits are more readily apparent and by requiring scientists to keep useable therapies and products at the back of their minds when planning and conducting their research.

The CTSAs explicitly focus on the creation of interdisciplinary teams, with team members working together to transform basic science knowledge into useable therapies, a shift from how scientists typically work. Where most scientists stay within their discipline's boundaries, translational science requires its scientists to interact with those from a variety of disciplines. It requires skills related to teamwork, such as cooperation and communication. In these teams, translational scientists must work out what their common goals are and what each can contribute, figure out how to be understood across disciplinary boundaries, and balance individual goals with those of the team. Of course, the skills needed for successful teamwork are not completely foreign to basic scientists. Labs often require teamwork, at least some of the time. However, the interdisciplinary nature of the teams has shown to be problematic, requiring competencies not usually required of scientists, such as integrating concepts and methods from multiple disciplines in designing interdisciplinary research protocols and sharing research from his or her discipline in

[5] Caren Heller and Inmaculada de Melo-Martín, "Clinical and Translational Science Awards: Can They Increase the Efficiency and Speed of Clinical and Translational Research?," *Academic Medicine* 84, no. 4 (April 2009): 425.

language meaningful to an interdisciplinary team.[6] In response, one of the institutions awarded a CTSA developed training programs to help researchers develop interdisciplinary skills through analysis of case studies and application of skills in an interdisciplinary group.[7] Although that study reports on the experience of one institution, the problems they encountered in their interdisciplinary teams are likely problems for other institutions as well. The CTSA's explicit emphasis on interdisciplinary teams and the skills needed brings their cultivation to the forefront of translational science and can be seen as sanctioning these values for scientific practice in general.

Additionally, these awards require the translational scientist to tackle facets of her work that other scientists may only cursorily consider, by requiring investigators to engage with the community. Although how the CTSA institutions and investigators engage with the community may vary, key features include "working collaboratively with and through groups of people affiliated by geographic proximity, special interest, or similar situations to address issues affecting the well-being of those people," "bringing about environmental and behavioral changes that will improve the health of the community, "involv[ing] partnerships and coalitions that help mobilize resources and influence systems, chang[ing] relationships among partners, and serv[ing] as catalysts for changing politics, programs, and

[6] Kristine M. Gebbie, Benjamin Mason Meier, Suzanne Bakken, Olveen Carrasquillo, Allan Formicola, Sally W. Aboelela, Sherry Glied, and Elaine Larson, "Training for Interdisciplinary Health Research: Defining the Required Competencies," *Journal of Allied Health* 37, no. 2 (Summer 2008): 69.

[7] Elaine L. Larson, Timothy F. Landers, and Melissa D. Begg, "Building Interdisciplinary Research Models: A Didactic Course to Prepare Interdisciplinary Scholars and Faculty," *Clinical and Translational Science* 4, no. 1 (February 2011): 39.

practices."[8] Community engagement requires translational scientists to work with the community with the goal of bettering the community. And like the goals of efficiency and interdisciplinary teams, attempts at fulfilling the community engagement requirement have encountered some obstacles, such as defining community engagement, deciding upon at what point in the research process to engage the community, and then engaging the community in a meaningful way.[9] In searching for ways of fulfilling the requirement, one institution awarded a CTSA surveyed the relationships between the CTSA community engagement program and practice-based research networks (PRBN), which are groups of mostly primary care physicians that collaborate on research issues relevant to routine care,[10] where many have established relationships with their communities. The authors argue that the structure and function of the PRBNs could be instrumental in linking translational science with communities.[11] Alternatively, frameworks established by community based participatory research could guide translational science when engaging with the community. Community based participatory research places community members and researchers as engaged in a joint process where both contribute equally through a co-learning process, involving systems development and local community building and achieving a balance

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[8] Clinical and Translational Science Awards Consortium Community Engagement Key Function Committee Task Force on the Principles of Community Engagement, *Principles of Community Engagement*, 2nd ed., (June 2011), 7, http://www.atsdr.cdc.gov/communityengagement/pdf/PCE_Report_508_FINAL.pdf.

[9] Nancy E. Hood, Tracy Brewer, Rebecca Jackson, and Mary Ellen Wewers, "Survey of Community Engagement in NIH-Funded Research," *Clinical and Translational Science* 3, no. 1 (February 2010): 21-22.

[10] Lyle J. Fagnan, Melinda Davis, Richard A. Deyo, James J. Werner, and Kurt C. Stange, "Linking Practice-Based Research Networks and Clinical and Translational Science Awards: New Opportunities for Community Engagement by Academic Health Centers," *Academic Medicine* 85, no. 3 (March 2010): 476.

[11] Ibid., 482.

between research and action.[12] Community engagement for the CTSAs is still in its nascent stages with each program working out what works for their research and the communities. It initiates a significant shift from how science has traditionally been carried out, requiring translational scientists to keep their work's context in mind, through engaging with the community. Regardless of how community engagement is carried out, to fulfill its key features, translational scientists must take into consideration the community's interests and needs, work with an eye towards advocating for changes in the structures and policies in ways that benefit the community, and tailor their projects in ways that help the community.

The goals and intentions of the CTSAs can be seen as pointing the way for the future direction of science in general. The increased emphasis on interdisciplinary teams, community engagement, and efficiency all function to speed the transformation of scientific knowledge into useful therapies and products, but in a way that requires scientists to take their work's contexts into account. Translational science requires its scientists to be sensitive to the needs and perspectives of their community and team members. The creation of interdisciplinary teams and requirement for community engagement forces the team members to think beyond their home disciplines, to see value in other perspectives, and to reevaluate how they understand their work in light of those other perspectives. Ideally, translational scientists would begin to look beyond their specific research and understand how their work fits within a much larger context. If the process of translational science is broken into four stages, beginning with planning the basic research to human

[12] Meredith Minkler and Nina Wallerstein, "Introduction to Community-Based Participatory Research," in *Community-Based Participatory Research for Health : From Process to Outcomes*, ed. Meredith Minkler and Nina Wallerstein (San Francisco, CA: Jossey-Bass, 2008), 9.

subjects trials to implementing successful therapies to refining the therapies' use, social and moral questions permeate every stage. The challenges and questions its practitioners will face will likely be a mix of old issues and old issues reframed in new ways, with a few completely novel problems. Some of the questions that translational science must contend with are widely applicable to the whole research practice, questions about the ethical limits of scientific inquiry, managing conflicts of interest, and general research ethics compliance.[13]

However, the reframing of science into a translational one also brings forth new ethics questions or presents old questions in new ways. For example, even with the push towards efficiency which may reorient the public's and science's perspectives of how science is situated in society, translational science is unlikely to change how scientists produce knowledge. Basic scientists will still devise experiments in pursuit of answering a research question and clinical research will continue to rely upon randomized controlled trials with patients. Translational science's emphasis on efficiency will likely cause some shifts in science, but it is unlikely to completely change the structure and production of scientific knowledge, unlike the case with scientific management in the early twentieth century, which completely restructured the tasks workers did and how they did those tasks. Despite the shifts translational science may bring, science will likely continue to be practiced much like it has been practiced in the recent past, keeping the scientific landscape mostly the same. This grounding can be helpful when examining some of translational science's more novel features. Then when thinking through the challenges efficiency faces and poses, such as its

[13] Robyn S. Shapiro and Peter M. Layde, "Integrating Bioethics into Clinical and Translational Science Research: A Roadmap," *Clinical and Translational Science* 1, no. 1 (May 21, 2008): 68.

high costs and fragmented infrastructures and whether or not efficiency should even be a goal of science, the translational scientist could see these problems as new variations on some of science's recurring general themes: the funding needed to support science, how science is situated within the institutions that house it, and what goals and values science should hold and if efficiency should count among them. These are all questions science has been grappling with since its inception, taking on new incarnations. And while the questions about funding and infrastructure must and will be solved eventually, questions about science's values will likely never be settled, but must be continually visited as the practice of science changes.

Even if translational science presents completely novel obstacles with no precedents, the skills of discernment and contextualization the scientist cultivates will be critical in helping her work through them. When facing the obstacles that hinder translational science, the skills needed for examining its moral and social features can help prepare the translational scientist address these obstacles, regardless of whether or not she has previously encountered that particular problem. For working through translational science's obstacles then, the translational scientist will need the skills of discernment and contextualization that virtue ethics emphasizes and that the humanities can further deepen. Situating science within a virtue ethics framework draws attention to the importance of the moral agent and her character for practicing science well. Although virtue ethics itself does not bring scientists' social responsibility together with science practiced well, once that responsibility to reflect on science's social and moral dimensions becomes accepted as part of science's *telos*, then virtue ethics can help the moral agent clarify and identify them.

Virtue ethics' focus on the scientist's character places the moral agent squarely in the center when developing a science that is practiced well. This central position emphasizes to the scientist the importance of her character for developing a contextualized science. As virtue ethics provides a flexibility that is dependent on the scientist's character and the particular situation, it allows the scientist to choose among several paths for virtue, while also highlighting that the process the scientist takes to get to a particular action is just as significant as the action itself.

Because the moral agent's reasons, motivations, and process are important features of developing virtue, cultivating *phronêsis* is critical. The capacity to identify and follow a virtuous path is dependent upon the ability to contextualize and carefully examine a situation, picking out its important features and relevant details. *Phronêsis* enables the scientist to plan a sound set of experiments, revise the experiments appropriately when problems arise, and construct knowledge from the data set. But it also enables the scientist to contextualize her work within its larger social and moral context, to identify the important stakeholders, to envision the values she would like her work to embody. *Phronêsis* enables her to clarify the framework from which she works, to reflect on the factors that caused her to shape the questions the way she does, to discern the social and moral dimensions she wants to bear upon her work. Virtue ethics draws attention to the scientist's character in developing a contextualized and responsible science and *phronêsis* gives the scientist the capacity to identify and interpret the factors necessary for that type of science.

Contextualizing Science

With this brief review of the role of virtue ethics in developing scientists' social responsibility, I now turn towards examining how the humanities can help the scientist cultivate this contextualized, reflective practice of science. Using sources from history and literature, this work's discussion of the various figures of the scientist shows how science's ethical features are shaped by the scientist's character. Frankenstein stands as a symbol of mad science not only in his goals of building the Creature, but also, and arguably more so, in his abandoning the Creature and his refusal to acknowledge any responsibility owed the Creature or society for much of the novel. The heroic scientist, as exemplified through Arrowsmith and Walter Reed, stands as an emblem of science's promises of future benefit, but as we have seen, upon closer inspection does not stand in diametric opposition to the mad scientist, instead sharing defining characteristics with the mad scientist. The heroic scientist is cast as a worthy figure, but is revealed to be as ethically suspect as the mad scientist. Indeed, all of the figures are ethically fallible, as Cliff and Lydgate demonstrate for the ordinary scientist. These characters are crafted with certain weaknesses and habits of mind that occlude their scientific work. The ordinary scientists illustrate how a person's framework, biases, and values all have great bearing on the production of legitimate scientific knowledge.

Now, how can these figures help the real-world scientist? What can she learn by reflecting upon them? And how do they help contextualize her work? All the figures position the scientist's character as critical for developing an ethical and reflective science. Because the mad and the heroic scientists placed producing science for one reason or another above all else, they failed to reflect on their work's social and moral features. This failure was located in the scientist's characters; their unwillingness to consider their work's social and moral dimensions resulted in ethically unacceptable science. These two figures may serve as cautionary figures for the scientist, as reminders to tend to her work's social and moral features. The ordinary figure is more overtly useful for the real-world scientist because it carefully and clearly shows how one's habits of mind can subtly, but powerfully influence one's scientific inclinations. Although most of the examples used are works of fiction, they bring concreteness to the abstract arguments about the importance of tending to science's context to the real-world scientist. In studying these figures and their stories, the scientist comes in contact with other moral and social dimensions of science, questions that may not bear directly on her character and its role, but are still important for the development of a socially and morally reflective science. *The Island of Doctor Moreau* raises questions about the fair and humane treatment of animals, the actions of the Yellow Fever Commission bring up the issue of informed consent and coercion in human subjects research, and *Oryx and Crake* shows a bleak dystopian future that directly results from an overweening science. The perspectives and analysis of science given by the humanities expose the scientist to the multitude of features that make up science's context, raising the scientist's awareness to those issues and helping her revise and clarify her position in relation to them. The humanities can sketch versions of science that are rife with its social and moral features, bringing them to the forefront. Reflection upon them can help the scientist work through her work's social and moral features.

Beginning steps are being made asking scientists to reflect on their work's moral features. In response to various issues of research misconduct, in the 1980s the Committee on the Integrity of Research appointed by the Association of American Universities and the Association of American Medical Colleges each issued reports that called for structures and policies to be established to deal with various issues of research misconduct should they occur. By the end of the decade, the Public Health Service and the National Science Foundation had established basic definitions of and procedures for responding to research misconduct.[14] However, these efforts were designed to address instances of misconduct after they had occurred, not to promote a reflective and ethical practicing of science.

A shift towards addressing some of science's ethical and moral issues in both the formal and informal curriculum began with the Institute of Medicine's report *The Responsible Conduct of Research in the Health Sciences*, which recommended "instruction in the standards and ethics of research," possibly through seminars or courses, as well as through professional mentoring where "investigators communicate responsible research standards in their interaction with trainees and students."[15] The NIH announced that, effective July 1, 1990, those receiving funding through National Research Service Award (NRSA) institutional training grants "must include a description of the formal or informal activities related to the instruction about the responsible conduct of research that will be

[14] Nicholas H. Steneck and Ruth Ellen Bulger, "The History, Purpose, and Future of Instruction in the Responsible Conduct of Research," *Academic Medicine* 82, no. 9 (September 2007): 829-830.

[15] Committee on the Responsible Conduct of Research, "The Responsible Conduct of Research in the Health Sciences," (Washington, D.C.: Institute of Medicine, 1989), 30, http://www.nap.edu/openbook.php?record_id=1388&page=R1.

incorporated into the proposed research training program."[16] This requirement was soon expanded to include all pre- and post-doctoral NRSA supported trainees, and later, all graduate and post-doctoral NIH supported trainees.[17] The new policy did not set a formal curriculum, instead leaving it up to the institutions to develop their own structures for teaching responsible conduct of research. It did, however, recommend teaching on the topics of conflicts of interest, data recording and retention, professional standards and codes of conduct, responsible authorship, institutional policies and procedures for handing allegations of misconduct and policies regarding the use of human and animal subjects.[18] Several years later, the National Science Foundation followed suit and added a requirement for responsible conduct of research to their Integrative Graduate Education and Research Traineeship program.[19]

These requirements led to widespread development of programs and courses teaching the responsible conduct of research. As the major federal funding agencies for the sciences now have this requirement and the vast majority of trainees receive funding from at least one of them, most institutions require all their graduate students and post-doctoral fellows to take what curriculum they have developed to meet the requirement. As no

[16] National Institutes of Health and Drug Abuse Alcohol, and Mental Health Administration, "Requirement for Programs on the Responsible Conduct of Research in National Research Service Award Institutional Training Programs," in *National Institutes of Health Guide for Grants and Contracts*, (Bethesda, MD: National Institutes of Health, December 22, 1989), 1, http://grants.nih.gov/grants/guide/historical/1989_12_22_Vol_18_No_45.pdf.

[17] Steneck and Bulger, "The History, Purpose, and Future of Instruction in the Responsible Conduct of Research," 830.

[18] National Institutes of Health, and Drug Abuse Alcohol, and Mental Health Administration, "Requirement for Programs on the Responsible Conduct of Research," 1.

[19] Steneck and Bulger, "The History, Purpose, and Future of Instruction in the Responsible Conduct of Research," 832.

curriculum was detailed, unsurprisingly, what institutions have developed to address responsible conduct of research varies widely. Some offer all-day marathon sessions that span a few days, others have lectures for an hour or two over a six-week or a semester-long period discussing various topics. What topics are discussed and the structure and extent of these discussions also varies considerably.

Despite the lack of guidelines and the resulting wide range, the development of teaching about responsible conduct of research is commendable. It is a good step towards bringing consideration of science's moral features into a conception of a science practiced well. But the topics the reports suggest are the main topics the various courses address, largely covering the issues of authorship and misconduct, conflicts of interest and research on human and animal subjects, to name a few. Again, these are important topics that need to be addressed. But the main topics discussed in these courses tend to be the ones that are, in a sense, inward facing. What is often taught in the responsible conduct of research courses largely tackle ethics as they pertain to practicing a science that promotes producing sound scientific knowledge, but not necessarily focusing on promoting a science that is also responsive to its wider context and moral features. Put another way, research ethics courses oriented this way make doing good in science synonymous with doing science well, where "motivat[ing] scientists to ethical behavior [stems from] emphasizing reasons internal to science."[20] This is not to say these courses never attend to questions of the scientist's character, science's potential implications, or its context, but those are not main focuses of the courses and the discussions that may ensue about them is grounded in their being

[20] Kenneth A. Richman, "Responsible Conduct of Research Is All Well and Good," *American Journal of Bioethics* 2, no. 4 (Fall 2002): 61.

linked to one of the other topics. The courses largely focus on promoting and upholding science's already established *telos* of producing sound scientific knowledge and teaching trainees about the ethical issues that may arise in its pursuit.

Thus to fulfill a broad vision of a science well-practiced that includes being mindful of its social context, with the intent of producing knowledge that is scientifically sound, as well as responsibly and ethically derived, the courses that teach trainees about the responsible conduct of research could include topics covering science as a shaper of society (and vice versa), the potential dangers and benefits of science's products, the difficulties and problems of separating the process of science from its end products, and how the scientist and her character are influential factors in science's development and the public's perception of science. The focus of these courses could be expanded to also include reflection on the scientist's place in society, whether or not scientists have a social contract, or what areas of the scientific practice are socially constructed. Understanding science's moral and social features is not mutually exclusive to the production of sound scientific knowledge, of course. In some cases, it may be beneficial to that purpose, such as reflecting upon how one's seemingly small equivocations and unrealized personal desires and biases can result in unintentional research misconduct and faulty data, as in the case of Cliff in *Intuition*. But to fully address science's moral and societal features, explicit exploration of these topics is critical, regardless of whether they appear to contribute to the production of sound scientific knowledge.

And in exploring this broadened scope, scientists can turn towards the humanities to help them grapple with understanding science's many moral features and develop their work in a way that is responsible and ethical, as well as scientifically sound. Using texts from the humanities for discussing science's moral features may slowly be gaining traction. In January 2002, the President's Council on Bioethics discussed Nathaniel Hawthorne's short story, "The Birthmark." Chairman Leon Kass, in explaining the selection, positioned the story as a beginning point for reflection on science's goals within modern society, specifically its drive to eliminate defects in the pursuit of perfection and the tensions that reside in the desire for perfection and the limits of that desire. He used the story as a type of bridge between people of differing disciplines for starting conversations about the pressing issues that are pertinent to everybody. And he hoped the story would illustrate "there is a wide and wealthy treasury of materials beyond the kind of literature produced by people like myself that can be fruitfully used to deepen our understanding of the meaning of biomedical advance."[21] Somewhat similarly, in their 2011 report on research involving animals containing human material, the Academy of Medical Sciences mentions Wells's *The Island of Doctor Moreau*, Shelley's *Frankenstein*, various children's stories, and two of Kafka's stories in the section on ethical and social concerns.[22] The report uses these pieces to illustrate various concerns that may be specific to this kind of research, animal welfare and research on animals in general, human and animal dignity, and humans' relationship to

[21] President's Council on Bioethics, "Science and the Pursuit of Perfection: Discussion of Nathaniel Hawthorne's Short Story, 'The Birthmark'," *President's Council on Bioethics*, created January 17, 2002, accessed May 16, 2012, http://bioethics.georgetown.edu/pcbe/transcripts/jan02/jan17session2.html. Kass eventually compiled "The Birthmark" and other selections from literature, history, philosophy, and religious studies into a collection that examined topics such as vulnerability and suffering and human dignity. Leon Kass, *Being Human: Core Readings in the Humanities* (New York, NY: W. W. Norton, 2004).

[22] The Academy of Medical Sciences, "Animals Containing Human Material," *The Academy of Medical Sciences* (July 2011), 71-73.

animals. Although the report rejects Wells's characterization of humanized animals, it uses *Frankenstein* to launch into a discussion on fears about humanized animals, specifically primates, and an overreaching science that "plays God." It uses children's stories of animals with human capacities and Kafka's story "A Report to an Academy," written from the point of a view of a caged ape who worked to become humanized for freedom, to explore humans' relationship with animals, specifically in a stewardship role.

The use of literature from the humanities by the President's Council on Bioethics and the Academy of Medical Science's report is a promising step towards incorporating the humanities into debates about the practice of science and what science may hold for our future. These examples nicely illustrate how they can be used as launching points for grappling with some of science's moral dimensions, particularly as they pertain to questions of the ought brought on by scientific practice. And while scientists did make up some of the composition of both groups, a more widespread and structured effort is needed in getting scientists to reflect on science's moral and social dimensions if that is to become a part of good scientific practice. Perhaps the structure and efforts of the responsible conduct of research courses could take cues from these uses of the humanities in exploring a contextualized and responsible science.

A Humanities-Informed Program for Training the Translational Scientist

If the present efforts of the responsible conduct of research courses and incorporation of the humanities into the sciences can deepen the translational scientist's understanding of her work's social and moral contexts, what might that involve? What might a humanities informed translational science training program look like? As the

CTSAs are funded through the NIH, translational science trainees must take the responsible conduct of research course their institution offers. While this course serves as a good beginning point for giving them at least a cursory introduction to some of the typical ethical and social problems scientists encounter over their careers, it is not sufficient for developing the skills the translational scientist needs to fully consider her work's social and moral contexts. And as previously mentioned, those courses typically focus on ethical issues as they pertain to the production of scientific knowledge.

Translational science cannot rely solely on the responsible conduct of research courses for developing a translational scientist that is attentive to her work's social and moral dimensions. With the push towards translational science, some institutions have developed additional training programs for scientists interested in translational research. The University of Connecticut has developed a Master's program designed to supplement terminal degrees, such as PhD or MD, with the purpose of "provid[ing] methodological and practical training in areas that traditional programs leave out." This program includes courses that discuss human-subjects issues, data management, and writing papers and grants. Over the course of the program, students develop a literature review of publishable quality, an empirical study or grant application, and must pass an oral exam.[23] Somewhat similarly, the Mayo Clinic developed a predoctoral program to provide the required PhD level education for medical students, a postdoctoral program and other career development opportunities, and a research management program for study coordinators and other members of the research team. They expanded their curriculum by offering additional

[23] Elaine Musgrave, "The Master of Science in Clinical and Translational Research at the University of Connecticut," *Clinical and Translational Science* 1, no. 2 (September 2008): 92.

areas of concentration, their learner groups by developing programs for groups ranging from medical students to administrative staff, and the learners' settings by collaborating with the local community college and providing field experience for students.[24]

In these instances, with the development of programs specifically designed to train a translational scientist, the humanities can be incorporated into these programs' courses and examinations, such as assigning pertinent readings from the humanities in conjunction with the teaching of scientific knowledge or requiring students to review historical, literary, or philosophical literature discussing some facet of their work as part of preparing for presentations and exams. Or additional mandatory courses may be developed that explores science's relationship with society, its general moral, ethical, and philosophical features, and their development and present incarnations. Programs training the translational scientist could encourage independent study of a topic in science for an in-depth view, requiring students to explore some of its social and moral contexts by drawing from the humanities. And presumably these programs designed to train the translational scientist draw students from a wide variety of disciplines. Course assignments could include group projects where groups must be composed of members from different disciplines and must work together to devise an experimental protocol, while also reflecting on their project's social and moral contexts. And depending on an institution's available resources and structure, courses may be jointly taught by faculty in the humanities and the sciences, which can be important, as most scientists will not be adequately trained to fully discuss the issues the humanities

[24] W. Charles Huskins, Karen M. Weavers, Joan F. Gorden, and Sherine Gabrie, "Training the Next Generation of Translational Science Teams," *Clinical and Translational Science* 1, no. 2 (September 2008): 95.

explores. Additionally, possibly with enough humanities incorporated into the syllabus, courses may be cross-listed between disciplines, putting translational science trainees in closer proximity to those studying the practice of science in the humanities, which may foster increased dialogue and collaboration between the sciences and the humanities.

Outside of classroom-based training, the programs can provide fieldwork opportunities that let the translational science trainee see her work's context first hand. This may include participating in outreach or educational programs, getting feedback from community members about research areas and procedures, or holding public discussions and seminars about possible projects. Through these venues, translational scientists can begin to discern the needs of the community, what research might be appropriate for it, and how. These options not only provide additional perspectives for the translational scientist piecing together her work's larger context, but also for cultivating the skills she will need for community engagement component of the CTSA. Similarly holding courses with students from many disciplinary backgrounds, requiring their cooperation on projects, and structuring courses that draw from many disciplines can help foster the skills needed for successful interdisciplinary teamwork that the CTSA aims to achieve.

However, for the humanities to be used to its fullest extent when brought together with translational science, it cannot be simply a cheering section for translational science. While translational science might open a path for the humanities to find a place in the practice of science, a humanities approach to translational science should have a critical dimension, examining how translational science fits with science in general, how it reimagines some of science's priorities and values, and what that might mean for science's future. If the task of the humanities in translational science is to help scientists develop the capacity to contextualize and situate their work within its larger social and moral dimensions, then those same skills of critical analysis and discernment can be brought to bear on translational science itself. For example, translational science's goal of efficiency touches upon the long-standing tension between having a specific goal direct the investigator (i.e. develop a vaccine for the flu) or having the science direct the investigator's next line of inquiry, with no stated goal for potential therapy. The humanities can be used to critically examine translational science's push towards efficiency, asking questions about what may be lost with that focus, what may be gained, how that focus may change science's relationships with industry, academia, and the public, and how a widespread shift towards efficiency may change what questions science pursues and what knowledge it produces.

Let's take the sickle cell example discussed in chapter 3 and place it within a translational science context for sketching what a humanities informed training program might include. For the translational science trainee, classes in her training program could include material from many disciplines that discusses the physiology and pathology of sickle cell anemia (microbiology, genetics, hematology), available management strategies (pharmacology, hematology), and literature discussing its relationship with race and stigmatization and the patient's perspective (history, literature, sociology). The trainee and her group do their final presentation on developing an experimental protocol exploring a physiological interaction of the sickle cell in tissue culture, speculating what therapy could result and how it could be tested in the community if successful, and what biases and burdens the therapy could pose. The trainee decides to further pursue her interest in sickle cell and its dimensions, more specifically, its social and moral contexts and the burdens the patients shoulder, and chooses to do an independent study. Besides, she knows her qualifying exam committee will expect her to discuss some of science's social and moral questions and thinks this independent study will be good preparation. Fortunately, the course that sparked her interest in sickle cell anemia's larger contexts included discussions led by a humanities scholar interested in the practice of science, who agrees to help her in her independent study. Although not quite the humanities scholar's area of study, he points her towards areas he thinks may be fruitful, such as further studying sickle cell's historical development in its relationship with race and with science, reading patient narratives and speaking with patients and their families about what it is like to live with sickle cell disease, and, more broadly examining blood as cultural and religious symbols and how constructions of blood shape how diseases of the blood are understood. Useful texts might include Keith Wailoo's *Dying in the City of the Blues: Sickle Cell Anemia and the Politics of Race and Health,* John Hoberman's *Black and Blue: The Origins and Consequences of Medical Racism,* or Melissa Meyer's *Thicker than Water: The Origins of Blood as Symbol and Ritual* for their discussions about disease, blood, race, and community, helping our trainee explore the many social and moral factors that intersect through sickle cell anemia.[25] Additionally, our trainee actively participates in the public

[25] Keith Wailoo, *Dying in the City of the Blues: Sickle Cell Anemia and the Politics of Race and Health* (Chapel Hill, NC: University of North Carolina Press, 2001), John Hoberman, *Black and Blue: The Origins and Consequences of Medical Racism* (Berkeley and Los Angeles, CA: University of California, 2012), Melissa Meyer, *Thicker Than Water: The Origins of Blood as Symbol and Ritual* (New York, NY: Routledge, 2005).

seminars her program sponsors and even presents on the scientific, medical, and social features of sickle anemia for one of them.

The training of the translational scientist could be interwoven with the humanities, providing some of translational science's context and helping the translational scientist develop the skills she needs for working on interdisciplinary teams and placing her work within its larger contexts. Despite the development of specialized training programs, presumably the graduate career of the translational scientist in general would resemble the path most graduate students in the sciences: first, coursework and selecting a lab, then proposing a project, working on the project for a number of years until she has accumulated enough data, then writing and defending her dissertation. While training the translational scientist may be different from that of the typical graduate student in the sciences, likely, it will not be radically different. Thus the ideas for developing humanities informed translational science training program are widely applicable to the development of a humanities informed science training program *in general*. If science practiced well includes scientists reflecting on their work's social and moral dimensions and incorporating those reflections into the way they practice science and exploration of the humanities are a way of cultivating that capacity, then science training programs in general can incorporate these ideas when training scientists. I chose to focus on how translational science may incorporate the humanities because translational science seems to be heralding shifts for the general practice of science and because of the stated goals of the CTSAs seem to more closely resemble the vision of science practiced well that I have argued for in this work. Exploration of the humanities can help the translational scientist develop the skills of contextualization, of viewing and understanding alternate perspectives necessary for meeting its goals of working on interdisciplinary teams and engaging the community as emphasized by the CTSAs. But by no means are the suggestions limited to training the translational scientist. Translational science serves as a useful example for exploring how the humanities can be brought to bear on the sciences in general. Admittedly, many, many factors must come together—curriculum development, institutional support, qualified faculty, to name a few—in order to realize the example above, much more than just the motivated scientist. However, developing a successful humanities informed training program for science cannot be done without dedicated scientists who believe that science practiced well includes attending to its social and moral features when producing scientific knowledge.

Science is an ever-changing practice, requiring its practitioners to adapt accordingly. This concurrently with the public's mixed position towards science, simultaneously wary and hopeful of its new developments, creates a multi-dimensional relationship between science and society that is continually fluctuating. These complexities point to scientists' particular obligation to practice a socially responsible science, a science that reflects upon its social and moral features. Scientists, in their role as scientists, ought to grapple with their work's relationship with society, exploring how science's frameworks and products have left indelible marks on the shape and direction of our future and how they play decisive roles in the development of an ethical and responsible science. While both scientists and lay people have a responsibility to acknowledge and examine how science functions not only as a source of knowledge, but also as a shaper of society, scientists in particular have a special obligation to do this precisely because of their position and authority in society. For scientists trying to understand science's moral and social features as science is continually restructured, this task may seem Sisyphean as the frameworks and perspectives they use to contextualize their work keep shifting. Whose perspectives should be taken into account? Which values should they focus on? However, these types of shifts do not happen overnight, but over years, sometimes generations, affording the scientific community time to reflect upon these questions and come to some sort of consensus. Additionally, despite the changes that may occur within scientific practice, a clear conception of science's *telos* can anchor scientists' reflections on their work's context.

Although some steps are being taken to reconcile the sciences with the humanities, the present relationship between the humanities and the sciences is tenuous, requiring much more work in seeing how their differing forms of knowledge can be brought to inform each other.[26] In this relationship, the humanities could serve as a rich resource for scientists exploring science's moral landscape. While the humanities are not likely to provide all of the answers, and certainly not in any definitive sort of way, they can provide useful frameworks and methods for preparing scientists to contextualize their work and for helping them critically think though the moral features of their practice and the changes that may come. The humanities can yield insights into how science functions as a shaper of society, helping scientists better contextualize their work. They can also help scientists

[26] Many have discussed the tensions between the sciences and the humanities and why they must be brought together for creating our future, most notably C. P. Snow in his 1959 Rede Lecture, "The Two Cultures," (Cambridge, UK: Cambridge University Press, 1998). Although his characterization of the problem and argument for resolution are important touchstones in debates about the two cultures, an in-depth exploration of the lecture is not within the scope of this work.

cultivate other useful skills important to the practicing of science, such as communication skills, both written and oral, for addressing a wide ranging audience. They can provide ethical frameworks for scientists to critically analyze science's future transformations. Both science and the humanities work towards the common goal of making sense of the human condition, of trying to understand what it means to be human. Science strives for this through defining the generalizable and universally applicable laws that govern natural phenomena. The humanities, on the other hand, focus on the details, the contexts, the situations that are part of the human experience and give rise to its huge range. And while the knowledge the humanities generates can be widely applicable across many human experiences, its purpose is not to be universally true. Instead, it examines various facets of the human experience, mulling over their meaning and how they intersect to make up the fabric of our lives. Regardless of their differences, science and the humanities are both valuable in helping us understand ourselves and our contexts, while also providing a framework for shaping our future decisions.

As major players in setting science's research directions, scientists must carefully consider what moral issues arise from their work. Although those issues may not be entirely new ones, since scientists are responsible for giving those issues their current incarnation, they then bear responsibility for helping society navigate its way through them. Staying within science's boundaries will not adequately prepare scientists to think through these issues. Engagement with the humanities can expose scientists to the difficult questions posed and the deep thinking required to confront these issues. While the sciences and the humanities are distinctly different enterprises combining the two is vital for deciding and acting with wisdom.

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Vita

Jiin-Yu Chen was born in Waco, Texas to Tsu Chen Chen and Hung Ing Chen on March 23, 1983. She attended the Connally Independent School District in Waco for most of her primary education. After graduating from Connally High School in 2001, she attended Rice University in Houston, Texas. There, she majored in English, graduating in 2005. She then moved to Galveston, Texas and worked as a research assistant in the Resuscitation Research Lab at the University of Texas Medical Branch before entering graduate school at the Institute for Medical Humanities. In 2010, Jiin-Yu moved to Baltimore, Maryland and worked as a research program coordinator for the Ethics in Clinical Practice Program at the Johns Hopkins Berman Institute of Bioethics. She currently lives with her husband, William Austin Elam, in New Haven, Connecticut.