Conflict, Competition, and Collaboration: Thomas Starzl's Team of Colleague-Allies and Colleague-Adversaries in Transplantation Science

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Surgeon and biomedical scientist Thomas Starzl's (1926-2017) contributions to modern medicine, especially the field of transplantation, are vast and include innovation to the transplant technique and the first successful liver transplant in 1964. The Dr. Thomas E. Starzl, M.D. Papers, a recently opened archive in the University of Pittsburgh's Archives & Special Collections, documents these ground-breaking contributions and includes letters, publication drafts, and memos from his personal and professional life. This paper investigates how Starzl strategized scientific team building and collaboration to encourage multidisciplinary sharing and network building. It reveals how he built a cooperative international community of collaborators in tandem with his own research team, and how he personally approached interaction with interprofessional colleagues with whom he strongly disagreed or closely competed. Evident in Starzl's archival materials as well as his autobiographical account of transplantation history, *The Puzzle People: Memoirs of a Transplant Surgeon*, is his ability to unite skilled and often competitively minded rival colleagues to address key issues like organ rejection and allocation in the early years of the field (~ 1960-1980). Theories from feminist epistemology and history of philosophy and science, combined with two high profile historical cases reflecting different leadership styles, aid in the analysis of key events and relationships from Starzl's career. New language (the terms colleague-competitor, colleague-ally, and colleague-adversary) is introduced to describe the potential of colleagues to collaborate and compete and to help characterize Starzl's approach to team building.

In the face of competition to be the first to transplant various organs or innovate a particular process, Starzl invited a diverse array of colleagues into conversation and collaboration. Anyone, but especially aspiring health science professionals, can learn a lot from how Starzl strategized scientific team building to encourage multidisciplinary collaboration. Understanding the strengths of Starzl's approach to interacting with colleagues with whom he strongly disagreed or closely competed is fruitful to those interested in constructing a professional network in tandem with their support system.

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Preface

I would like to take this opportunity to thank my friends, family, professors, and advisors who have provided valuable insights and support throughout my time working on this project. I want to thank all the members of my defense committee for their support, time, and feedback; especially Dr. Emily Herrington, Dr. M. Kathleen Kelly, and Dr. Lisa Parker for their unwavering support and guidance over the past two years. I am extremely grateful to Dr. Lisa Keranen, my external reviewer, for her fresh perspective and insights. I also want to thank Margarete Bower, Zachary Brodt, and the Archival Scholars Research Awards for introducing me to the Dr. Thomas E. Starzl, M.D. Papers and supporting my work with the collection. I am extremely grateful to Dr. John Fung, Dr. Andreas Tzakis, Peter Kratch, and Professor Carl Kurlander for providing expertise that elevated my project in ways I did not know were possible. I am also thankful to the University Honors College, especially Dr. Josh Cannon, Dr. David Hornyak, and Dr. Brett Say, for this opportunity and their support throughout this process.

1.0 Introduction

1.1 Thomas Starzl, His Archive, and the Focus of this Paper

Even though he was not the first to meaningfully theorize transplantation or to conduct a successful organ transplant, surgeon and biomedical scientist Thomas Starzl (1926-2017) is referred to as the father of transplantation (UPMC, 2017). He earned this title because — in addition to innovating transplant technique and transplanting the first liver in 1964 — he built the multidisciplinary medical team that transformed transplantation into a reliably successful procedure. Starzl's Pittsburgh-based team established many of the key procedures that made transplants a clinical "standard of care" for patients facing organ failure.

The Dr. Thomas E. Starzl, M.D. Papers, a recently opened archive in the University of Pittsburgh's Archives & Special Collections, contains over 400 boxes of letters, publication drafts, and memos documenting Starzl's professional and personal life. Examining Starzl's extensive correspondence with colleagues and patients alongside his numerous publications is fruitful to understand what Starzl did, specifically within the series of events that led to important transplantation innovation. Evident in his correspondence, as well as his autobiographical account of transplantation history, *The Puzzle People: Memoirs of a Transplant Surgeon*, is Starzl's ability to unite skilled and often competitively minded rival colleagues to address key issues like organ rejection and allocation in the early years of the field (~ 1960-1980).

Using a mixed-methods archival and close-reading approach to qualitative data analysis, this paper analyzes some narratives drawn from the recently opened Dr. Thomas E. Starzl, M.D. Papers. The narratives chosen show how colleagues of Starzl displayed movement on the spectrum

of agreeing and disagreeing about important concepts within the emerging field. It is noticeable that Starzl's colleagues were influential in his movement between research centers and often when past colleagues visited, together they would make substantial progress on a theory or procedure. It is rare to have access to a well-kept, organized, and voluminous record of the communication between prominent players in a scientific field. For each of Starzl's colleagues, their respective correspondences were reviewed, primarily focusing on times where important advances occurred with Starzl. Narrative guidance from Starzl's memoir and insights from archival material assisted in the generation of questions for his colleagues, many of whom are still actively conducting research. Data analysis and critique proceeded in a grounded fashion with evolving insights helping to refine and generate research questions. Anyone, but especially aspiring health science professionals, can learn a lot from how Starzl strategized scientific team building to encourage multidisciplinary collaboration. The resulting analysis includes applying existing theories and lessons uncovered in Starzl's narrative to personal experiences.

In the face of international competition to be the first to transplant certain organs or innovate a particular process, Starzl invited a diverse array of colleagues into conversation and collaboration. The dialogue Starzl helped foster between different transplant teams or transplant centers allowed early transplant pioneers to rapidly adapt to emerging challenges in the course of developing successful procedures. Even though they were constantly competing, these early pioneers established a culture of data sharing and collaborative conversation that allowed for great advances in the field. Starzl's approach of bringing competitors into conversation with each other not only enabled him to make contributions to transplant research that were revolutionary and ultimately foundational, but also constitutes an important scientific approach to study from a social-scientific point of view.

Starzl's memoir and archived correspondence provide rich ground to investigate how he constructed a network of transplant personnel. Supplementing analysis of these materials with interviews with his former colleagues, this project demonstrates how and from where Starzl incorporated new ideas into his own. When reviewing these materials, it was clear that Starzl distinguished his approach by intentionally integrating long-standing and new colleagues. Building a team was an essential part of Starzl's success. This paper investigates how Starzl strategized scientific team building and collaboration to encourage multidisciplinary sharing and network building. It reveals how he built a cooperative international community of collaborators in tandem with his own research team, and how he personally approached interaction with interprofessional colleagues with whom he strongly disagreed or closely competed.

1.2 Paper Outline

The comparative analysis of Starzl and two high profile historical cases reflecting different leadership styles enables the development of new conceptual vocabulary to parse the relational dynamics of competitive research contexts. These concepts for analyzing interpersonal dynamics in biomedical science and for responding strategically to their effect on research cultures and practices, rely on insights from feminist epistemology. The analysis addresses how, at least in the case of Thomas Starzl's career in transplantation, disagreement and competition can lead to collaboration, and can spark imagination, discovery, and innovation. While disagreement and competition may seem like negative factors, these moments can be transformed into collaboration and lead to knowledge generation. Theories from science and technology studies (STS), feminist

epistemology, and history and philosophy of science (HPS) will guide this analysis of Starzl's approach to scientific team building.

Section One will contribute language and develop concepts to help illuminate and emphasize colleague-competitor dynamics in the biomedical sciences. The terms "colleague-ally" and "colleague-adversary" will be defined and used to represent extremes of interpersonal interactions on a spectrum where cooperation and competition exist. In addition to providing theoretical terminology and framework for the rest of the paper, Section One will employ two case studies from outside transplantation to help define and illustrate the vocabulary of colleague-competition and provide comparative content for the analysis of Starzl's narrative. The well-studied history of President Lincoln's political strategy during the 1860 Presidential Election and American Civil War and the infamous story (among biologists) of Ukrainian agronomist Trofim Lysenko's politicization of science in Soviet Russia are examples of colleague-competition.

Lincoln has been recognized by historians and political scientists for his presidential cabinet-building strategy that employed former competing politicians, resulting in a multifaceted team that steered the country through a civil war (Goodwin, 2009). By contrast, Soviet biologist Trofim Lysenko dominated USSR agricultural studies with the personal support of Josef Stalin while disregarding the global scientific community and eliminating conflicting domestic views (Borinskaya, 2019, p. 1). Lysenko's failure to incorporate diverse perspectives and data into his research practices devastated Soviet agriculture and the transmission of scientific knowledge for generations (Borinskaya, 2019, p. 1). This disruption in knowledge transmission originated in the field of agriculture and quickly spread to various disciplines in the USSR as they each were influenced by state power and pseudoscientists (Graham, 2016).

Section Two will compare Starzl's approach to Lincoln's and Lysenko's to provide insight into how Starzl's integrative process led to success. Similar to Lincoln, but in contrast to Lysenko, Starzl's approach to innovation involved unifying perspectives from seemingly unrelated fields. The stories in this section range from Starzl's role in some of the first transplants, his move to Pittsburgh, and his contributions to transplant research and the training of future leaders in the field. Analysis of the collaborative dynamics and their effect on the research culture of Starzl and his colleagues will both inform and be informed by the development of concepts describing how to respond productively to colleagues in competition. These illustrations of competition include early contributors in the field, frequent collaborators, and successive generations of innovators. The historical examples of Lincoln, Lysenko, and Starzl illustrate scenarios in which individuals are faced with interprofessional and interpersonal competition while pursuing knowledge and power. All three individuals operated at the edge of what was known in their respective fields and left lasting impressions on their respective institutions and intellectual communities.

Section Three will illustrate that this analysis of Starzl's team-building strategy, while retrospective in nature, is applicable to modern team building dynamics. In Section Three, the vocabulary of colleague-competitor dynamics introduced in this paper — including the spectrum-indicating concepts of "colleague-ally" and "colleague-adversary" — will be demonstrated to have relevance for understanding and reforming contemporary educational programs and training program projects. The third concluding section will apply the concepts discussed in previous sections to the situation of pre-professional students facing internal and external challenges, like self-doubt or peer rivalry, and provide examples of how to adapt to those situations strategically.

2.0 Section One: Colleague-Competitor Dynamics and the Cases of Lincoln and Lysenko

This section will apply concepts from STS which focuses on how features of society and culture affect scientific research and innovation, HPS, and feminist epistemology to analyze Starzl's approach to scientific team building. I will focus specifically on the feminist concept of "situated knowledges". I will also introduce new terms to existing discourse on the sociology of knowledge-making: "colleague-competitor, "colleague-adversary", and "colleague-ally." These terms will be defined and illustrated using examples drawn from the narratives of Abraham Lincoln's and Trofim Lysenko's dissimilar approaches to their own colleague-competitor relationships.

2.1 Perspectives from Feminist Standpoint Theory

Feminist epistemology emerged as a response to traditional epistemology and philosophy of science. It draws attention to the value of taking into account an individual's positioning in the generation of knowledge when attempting to develop a comprehensive and accurate account of a problem or phenomenon. A feminist epistemological approach investigates the source of claims or beliefs, which includes the historical context and social power structures.

> Thinking of the care of a patient, for example, a feminist approach to understanding how the patient is progressing would take into account multiple perspectives when gathering information during morning hospital rounds. While a surgeon or other physician may have the most social power (e.g., greatest prestige, highest institutional authority, and highest salary), the report from the nurse, respiratory therapist, pharmacist, and medical student would all be taken into account in assessing whether the patient had progressed in her healing since the day before. The patient's own report—how she is feeling, her level of pain or strength, and her concerns—would also be taken into account to develop the

> most accurate view of her condition. (Parker[1], personal communication, November 8, 2021)

The consideration of information from different standpoints is epistemologically and ethically important. It furthers accuracy of the account and demonstrates respect for individuals with relevant expertise regarding the questions at hand (Parker, personal communication, November 8, 2021). A feminist epistemological approach rejects the notion of adopting a view from a single viewpoint when understanding problems and devising solutions. Donna Haraway describes her version of feminist epistemology by saying she is

> arguing for politics and epistemologies of location, position, and situating, where partiality and not universality is the condition of being heard to make rational knowledge claims. These are claims on people's lives. I'm arguing for[,] the view from a body, always a complex, contradictory, structuring, and structured body, versus the view from above, from nowhere, from simplicity. Only the god trick is forbidden. (Haraway, 1988).

The god trick Haraway rejects occurs when someone occupying a dominant position or representing a dominant framework presents a claim as a universal truth without acknowledging its origin. "Any claim is necessarily partial in two senses: first, any person's or perspective's claim is incomplete, and second, it reflects the interests of the person or collective making the claim and is thus partial rather than impartial" (Parker, personal communication, November 8, 2021). Haraway and other feminist epistemologists argue against attempting to generate knowledge from an aerial view without conversing with differently situated individuals.

Feminist standpoint theory focuses on how conditions and experiences are responsible for the power and knowledge that individuals have (Wood, 2012). The social situatedness of the individual lends that person power and knowledge, and thus knowledge is socially situated. The

[1] Feminist philosopher and bioethicist Lisa S. Parker provided insights on how feminist conceptual frameworks illuminate knowledge making practices through informal conversation and written feedback.

situatedness of an individual is characterized by the person's experiences, which are in turn influenced by social practices and social values (Stoetzler, 2002). Feminist standpoint theory argues "that those who have relatively less power within a particular social structure or power dynamic may have perspectives that have greater epistemological power" (Parker, personal communication, November 8, 2021). Within the different positionings, the "perspectives of the subordinated social groups have an epistemic advantage regarding politically contested topics related to their subordination, relative to the perspectives of the groups that dominate them" (Anderson, 2020).

> In fact, it is not merely the politically contested topics about which they may have an epistemological advantage: very mundane practical matters may be noticed by people with relatively less power because they must learn about features of their environment in order to survive or succeed within it. To use a nonhuman example, consider a household with two dogs: one a lively and large retriever, and the other a tiny Chihuahua-Dachshund mix. The smaller dog may be very aware where everyone's feet are at all times, to avoid being stepped on by either humans or the other dog, while the big dog need only be aware of the general position of the humans to be able to seek attention, affection, and food. (Parker, personal communication, November 8, 2021)

The situatedness of the subordinate in various power structures reveals "fundamental social regularities" and exposes "social arrangements as contingent and susceptible to change through concerted action" (Anderson, 2020).

> In the hospital rounds example, it may be the nurse who notices a change in the patient's excrement that signals an infection, or the patient may be able to report a change in the nature of her pain that signals either improvement or a new problem. The more powerful medical staff, who are not with the patient as consistently, do not have access to this level of detail that could nevertheless be critical to the patient's care. (Parker, personal communication, November 8, 2021)

Dialogue between different professionals on morning rounds connects their respective knowledge and provides a more accurate understanding of the patient's condition. Between the knowledge generation of differently situated individuals lies epistemic chasms that can be bridged through conversation (Stoetzler, 2002). The dialogue of these individuals connects their ideas and expands

on their individual and joint abilities to approximate truths and more accurately perceive reality (Stoetzler, 2002). Often, similarly situated individuals can form a group and share a social network or community, such as the transfer of information across a nurses' shift change (Stoetzler, 2002). Within groups, individuals are situated in a way that provides them with a unique perspective, and they are able to share knowledge with people of similar situatedness. Both within groups, and when bridging across differently situated groups, it is respectful to take everyone's perspective into account— at least initially— and it is ethically required to at least consider the perspectives of all stakeholders in a situation, and then decide whether and how to integrate the various perspectives. Because each person has a standpoint, each is valuable in generating knowledge.

These insights from feminist epistemology provide a theoretical framework for understanding how Starzl developed a multidisciplinary transplant team and successfully integrated knowledge from different sources. Starzl's commitment to diversifying who he collaborated with and incorporating collaborators representing diverse lineages, i.e., where and with whom they trained with, will be characterized in the next section. Many of Starzl's contributions, including multidisciplinary clinical teams, are part of the norm in transplantation. As a leader within one of the first transplant programs, Starzl was instrumental in the formation of multidisciplinary teams for the generation of transplantation knowledge as well as the care of transplant patients.

2.2 Colleagues in Competition

A strength of Starzl's approach to creating the transplantation treatment team was how he handled interpersonal dynamics, especially in the face of strong competition or disagreement. As described previously, interpersonal interactions and relationships are needed to shape and refine scientific knowledge. To date, the STS, HPS, and feminist epistemology literature have lacked clear language to describe how scientists initiate or maintain collaborative relationships with peers whom they strongly disagree with. A conceptual vocabulary is needed to describe how professionals navigate fluctuating interpersonal interactions. To aid discussion of Starzl's unique skills in colleague relationship management, and to contribute to the STS/HPS vocabulary, this paper introduces a new set of conceptual terms. The umbrella term "**colleague-competitor**" indicates the structural reality of science, or any space, where participants are always to some degree in competition. Colleague-competitors may be like-minded (i.e., largely in agreement on relevant scientific and other matters) or may differ. As people's beliefs, views, and theoretical commitments can vary over time, two colleagues may be like-minded at some times and differently-minded at others. Indeed, they may be like-minded with regard to some issues and simultaneously differ with regard to others. Moreover, people may be more or less likeable and congenial, and this also may vary over time for various reasons, including similarities or differences in beliefs (like - or different-mindedness) or degrees of congeniality. In fact, perhaps surprisingly, some may find it difficult to work with someone who is very pleasant and likeable, but who holds very different scientific commitments. It may also be difficult to work with someone who holds very similar beliefs, but whose interpersonal style makes him/her unlikeable.

The two terms, **"colleague-ally"** and **"colleague-adversary"** indicate two poles of the colleague-competitor spectrum where cooperation and competition both exist in a working

relationship. Both colleague-allies and colleague-adversaries fall under the term colleague-competitor.

2.3 Illustrations of Colleague-Competitor Relations

To illustrate and ground the concepts of colleague-ally, colleague-adversary, and colleague-competitor, two historical figures will be discussed. Abraham Lincoln and Trofim Lysenko, like Thomas Starzl, faced interprofessional and interpersonal competition while pursuing knowledge and power. Lincoln is recognized by historians for his presidential cabinet-building strategy that employed the incorporation of former competing politicians, resulting in a multifaceted team steering the country through a civil war (Goodwin, 2009). By contrast, Soviet biologist Trofim Lysenko dominated USSR agricultural studies with the personal support of Josef Stalin while disregarding the global scientific community and eliminating conflicting domestic views (Borinskaya, 2019, p. 1). Lincoln, Lysenko, and Starzl were each operating at the edge of what was known within their respective political or scientific fields. Their actions left lasting impressions on their respective institutions and members. After the illustration of how Lysenko and Lincoln built their cabinet of advisors, how Starzl constructed his research network will be analyzed in Section Two.

2.4 Lysenko's Lethal Epistemology

"Trofim Lysenko [an agronomist from a Ukrainian peasant family] probably killed more human beings than any individual scientist in history" asserts a 2017 article in "The Atlantic" (Kean, 2017, p. 1). In the 1930's, Lysenko rose to a high position of power within Soviet agriculture and his style of dictating science spread to different fields in Soviet Russia, resulting in unintentional harm to USSR citizens and intentional harm to his scientist colleagues (Graham, 2016). Lysenko denounced individuals with conflicting views to the secret police directly, and many were unjustly punished, suffering death, imprisonment, or psychiatric hospitalization (Graham, 2016). Prior to Lysenko, the Soviet Union's genetics community was one of the best, yet Lysenko's inability to work with anyone set Russian biology back a half-century (Kean, 2017, p. 1). The culmination of his actions occurring from roughly 1936 to 1965 is referred to as the Lysenko affair (Graham, 2016). Lysenko's methods and impact starkly contrasts Lincoln's and Starzl's approach to competition, and serves as a useful example to characterize the concept of colleague-adversary.

In the 1920's, just before Lysenko's emergence as a thought leader in biology, in Soviet Russia there were discussions through a political lens regarding the importance of human heredity (Graham, 2016, p. 49). Of the many debating the issue, Marxist geneticists and eugenicists were proposing the creation of a new eugenics that could help the Soviet Union (Graham, 2016, p. 55). Specifically, proponents of Lamarckism, which claimed that an organism's physical changes occurring during their lifetime could be passed to their offspring, were gaining popularity in Russia (Graham, 2016, p. 31). However, there was a growing majority of geneticists in Russia, aligned with western science in Great Britain and the United States, that disagreed with Lamarckism and later, Lysenko (Graham, 2016). Lamarckists and Lysenko both attempted to provide practical

assistance to Soviet agriculture and received the support of Stalin and proletarian radicals, they grew in popularity and power; the geneticists associated with academic, pre-revolutionary bourgeois families did not enjoy the same political support (Graham, 2016, p. 32). This divide in Soviet science was exacerbated during Lysenko's ascent to power as he described leading academic geneticists as traitors, counterrevolutionaries, and foreign agents, while claiming that they harmed Soviet agriculture, and denouncing them to the secret police (Graham, 2016, p. 72).

Supporters of the inheritance of acquired characteristics emerged throughout history, with each person proposing a different meaning of the term and mechanisms for it to occur in nature (Graham, 2016, p. 16). Lysenko pioneered his own theory, without integrating concepts from competing viewpoints, which quickly became a dominant form of thinking in Soviet Russia. Lysenko's approach to understanding heredity involved considering the relationship between an organism and its environment, and held that the latter determined heredity (Graham, 2016, p. 82). He refused to accept genes as the carrier of heredity and to integrate recent advancements in genetics, believing instead in the inheritance of acquired characteristics, or the idea that changes acquired by an organism will be passed to their offspring (Graham, 2016, p. 83). He used flawed experiments, ignored statistics, and fabricated evidence to support his claims (Graham, 2016, p. 83). Due to Lysenko's political support, engaging with his ideas was not merely a scientific exchange, but a political one as well. Lysenko shared with Marxist leaders an antipathy for the bourgeois and made promises regarding the future of Soviet agriculture that resulted in his receipt of the backing of the Soviet government (Graham, 2016, p. 73). Class hatred combined with an unsuccessful research program backed by state power equipped Lysenko with the tools to cause great harm (Graham, 2016, p. 77).

During Lysenko's ascent as a prominent Soviet scientist, the USSR was emerging from political isolation. Their early achievements in genetics to improve methods, concepts, and research were recognized abroad (Borinskaya, 2019, p. 2). The USSR supported formation of interpersonal relationships in science by sending researchers to places like the US and Germany (Borinskaya, 2019, p. 2). One of these foreign educated geneticists, Nikolai Vavilov, was leading USSR science in the 1920's by holding several powerful roles: president of the Lenin All-Union Academy of Agricultural Sciences (VASKhNIL), head of All-Union Institute of the Plant Industry (VIR) and Institute of Genetics, and member of the USSR Central Executive Committee, the highest body of Soviet state authority (Borinskaya, 2019, p. 3). In the early 1930's, the USSR attempted to address famine through agricultural innovation. Lysenko's vernalization idea— exposure of seeds to extreme cold prior to planting— was studied in the US by John Klippart, in Russia by Efim Grachev, and in Germany by Gustav Gassne (Borinskaya, 2019, p. 3). Lysenko expanded the use of the term vernalization to describe anything done to seeds prior to planting (Graham, 2016, p. 90). The result Lysenko was attempting to produce, early germination, was later obtained using complex and costly procedures that differed from Lysenko's methods (Graham, 2016, p. 89). Vernalization had been studied prior to Lysenko and is best explained using classical genetics, including dominant and recessive alleles, that Lysenko rejected (Graham, 2016, p. 87). Even with no evidence to support increased yields, the USSR implemented vernalization in 1931 and Lysenko promised to achieve high yields and varieties in half the time of other geneticists (Borinskaya, 2019, p. 3).

Instead of communicating and strengthening ties, Lysenko positioned his work to compete directly with the projections of other scientists. Instead of discussing data and methods to maximize production, he acquired knowledge from his peers and used it as a weapon when arguing

against them. He claimed that he could do better which resulted in his ideas being adopted by the Soviet government. They demanded that science leaders like Vavilov assist Lysenko (Borinskaya, 2019, p. 3). Lysenko proceeded to attribute his vernalization failures to his enemies; however, by 1935 the technique had proved to be unrealistic, laborious, and harmful as it decreased seed germination (Borinskaya, 2019, p. 3). The Soviet people faced a horrific consequence as there was a decrease in production of food, contributing to a famine (Kean, 2016). By this time, however, Stalin had begun his policies of terror in the USSR and placed Lysenko as the president of VASKhNIL and head of the Institute of Genetics, while sentencing Vavilov to prison (Borinskaya, 2019, p. 3). During the Great Purge, Lysenko accused several geneticists of hampering his methods and 12 of the 52 VASKhNIL academics were shot on the basis of these false charges in 1936-1938 (Borinskaya, 2019, p. 3). These political actions forced former opposers of Lysenko's ideas to take his side, including Iohann Eichfeld who replaced Vavilov as head of VIR (Borinskaya, 2019, p. 4). Lysenko's new politically- and fear-motivated converts pursued former Vavilov supporters, resulting in at least 26 being dismissed, 12 sentenced to prison or exile but later freed, and 10 arrests with fatal outcomes (Borinskaya, 2019, p. 3). After the 1948 VASKhNIL session, Lysenko's ideas became so-called state science and could no longer be criticized. Several thousand people were dismissed, demoted, or removed from leadership after this session (Borinskaya, 2019, p. 6). Lysenko's most well-known opponent, Nikolai Vavilov, perished in a labor camp (Graham, 2016, p. 7).

These events established a precedent of one person's experiences within each scientific community (physiology, cytology, physics, economics, and more) as the sole source of knowledge; any form of criticism was viewed as a direct attack on the USSR itself (Borinskaya, 2019, p. 6). Lysenko refused to meaningfully engage with different perspectives and the ideas generated from

those lived experiences, instead, he sought out methods to censure individuals that competed with his theories. Lysenko's impact was not limited to his ideas relating to agriculture, but also included the idea that one perspective, often led by one individual, with a set of methods and beliefs should dictate the field when producing knowledge. This approach disregards the epistemological value of recognizing other people's situatedness and the knowledge that can be produced from their different perspectives, and instead expands the chasms between the points of knowledge generation.

Recently, there has been an emergence of supporters and evidence for the inheritance of acquired characteristics, prompting the question, was Lysenko correct (Graham, 2016, p. 12) For the purpose of this paper, this development and the answer to this question are irrelevant. What is important is recognition that Lysenko's methods were deeply flawed as a matter of epistemology and scientific method. His approach to dealing with colleague-adversaries was not only unethical, but also epistemologically ill-founded and short-sighted. His ideas lacked a scientific basis, his methods were not scientifically well-grounded nor accepted by the broader scientific community, and he ignored available statistics while promising improved yields and touting inaccurate achievements (Borinskaya, 2019, p. 2). Lysenko serves as a radical example of viewing colleagues as solely adversaries, with no appreciation of their potential to be allies in pursuit of shared epistemological and practical scientific goals.

2.5 Lincoln's Remarkable "Team of Rivals"

While Lysenko immediately designated potential colleagues within a competitive space to be colleague-adversaries, and treated them accordingly, Abraham Lincoln employed a more

productive approach. Even prior to becoming a political figure, Lincoln's approach to colleague-competitors provided his peers with numerous opportunities to fulfill their potential to be colleague-allies. Throughout his career, Lincoln engaged with differently situated individuals across the political spectrum, as well as citizens not holding political office. Lincoln's conversation with these different perspectives allowed his views and approach to evolve into one that reflected the majority of the country.

At the top of President Obama's list of books to bring to the White House sat Doris Goodwin's *"Team of Rivals: The Political Genius of Abraham Lincoln"* (Burns, 2008). This memoir constructed the narratives of notable colleague-competitors in Lincoln's life during historic moments in the 1860 Presidential Election and American Civil War. Lincoln recognized the strengths of these individuals and filled his Presidential cabinet with these former competitors. Goodwin's book illuminates how Lincoln appointed, then won over, men who had previously opposed him. Of his many colleague-competitors, this section will focus on his colleague-adversaries from the 1860 Republican presidential nomination convention: Senator William Seward of New York, Governor Salmon Chase of Ohio, and Representative Edward Bates of Missouri. These former rivals evolved toward their status as colleague-allies and were able to unite under their shared goal of ensuring Black rights in America. Lincoln focused on his colleagues' shared vision even though they each held diverse aims in shaping the future of the country. Lincoln practiced an integrative approach in dealing with colleague-adversaries and appreciated the potential duality of adversary and ally.

Lincoln had debated or worked with most of the candidates for the 1860 Republican nomination and they all became leaders with distinct styles of thinking and approaches to nationwide problems. During this time, the major political groups splintered into more niche

political communities. Lincoln secured his party's nomination due to advantageous factors like the position of his political platform in the party's center, his home state's status as a crucial voting bloc, the convention's favorable location in Chicago, and his team's strategy secured enough delegates. Prior to the Republican National Convention of 1860, Lincoln aspired to be the delegates' second choice, as Seward held a clear lead over Bates, Chase, and Lincoln (Goodwin, 2005, p. 27). "To reach his goal of becoming everyone's second choice, Lincoln was careful not to disparage any other candidate. Nor was it in his nature to do so." Lincoln and his team strove "to antagonize no one" and base their appeal on "availability and expediency" (Goodwin, 2005, p. 358). They understood that at the end of the day, the delegates wanted to "nominate the man who could win" (Goodwin, 2005, p. 358). They worked multiple angles, met with delegates, personalized each approach, worked with newspapers, and filled seats in the convention hall with Lincoln supporters. Filling the hall with supporters showed strength and expediency, and one of his leading men, Swett, even confessed that it was "not the most deliberate way of nominating a President" (Goodwin, 2005, p. 363). Yet, it was an effective display of support.

"While the Convention was the defeat of Seward rather than the nomination of Lincoln", Goodwin claims, Lincoln went on to steer the country through an unprecedented civil war (Goodwin, 2005, p. 371). His success correlated with his ability to integrate differently situated individuals and their political affiliations, regardless of his personal history with them. After winning the nomination, Lincoln immediately set out to mend and then strengthen his relationships with the other contenders. Goodwin observes that this was something that many others forgot to do during their rise to fame, which hurt their chances in securing the nomination. While they served as his competitors, at least one, Goodwin mentions Salmon Chase as an example, had been an ally

in previous races (Goodwin, 2005, p. 52). Lincoln persisted to shape them into reliable allies and won the presidency.

After campaigning to achieve the Presidency, Lincoln once again called on his competitors' service as members of his cabinet. "On a blank card he wrote the names of the seven men he wanted. At the center of his list stood his chief rivals for the nomination— Seward, Chase, and Bates. The list also included Montgomery Blair, Gideon Welles, and Norman Judd, all former Democrats, as well as William Dayton of New Jersey, a former Whig. While several months would pass before the cabinet was assembled, subjecting Lincoln to intense pressure from all sides, he resolved that day to surround himself with the strongest men from every faction of the new Republican Party— former Whigs, Free-Soilers, and antislavery Democrats." (Goodwin, 2005, p. 409). While Seward and Chases wanted to fill the cabinet with personal loyalists, Lincoln desired individuals from diverse political backgrounds. The cabinet members' conversations would bridge differently situated individuals and knowledge generating groups which facilitated decisions that united and advanced the country.

Of the diverse individuals selected to serve in his cabinet and other important roles such as leaders in the army or staff in various departments, Seward and Chase are strong examples of transitioning from adversary to ally in their own, unique way. The third competitor from the convention, Edward Bates, fell into line and was willing to serve when called upon. When he lost the nomination, he was unwilling to campaign, but wrote letters praising Lincoln (Goodwin, 2005). His opinion persuaded his past colleagues and voters into seriously considering Lincoln. While serving in the cabinet as Attorney General, he was instrumental in helping Lincoln enact his war policies, while also expressing his conflicting viewpoint. Bates almost seamlessly transitioned from adversary to ally, and at low personal political costs as he had come out of retirement

(Goodwin, 2005). Seward and Chase will serve as more complex examples of the fluctuation between colleague-adversary and colleague-ally.

2.6 Lincoln's Golden Fleece: William Henry Seward

Lincoln's strongest competitor at the Republican nomination of 1860 was William Henry Seward. He served as senator for over a decade and two-term governor of New York prior to serving as Secretary of State on Lincoln's cabinet (Goodwin, 2005, p. 27). He expressed a genuine curiosity and desire to help people with their problems and championed a stronger stance against slavery, and thus was branded as a radical Republican (Goodwin, 2005, p. 34). When Seward met Lincoln in 1848 in Massachusetts, he encouraged Lincoln to develop a stronger antislavery stance (Goodwin, 2005, p. 395). Seward held a strong lead prior to the Republican Convention of 1860; however, he did not win the first ballot which provided Lincoln's team with time to secure enough votes to win the second ballot and win the nomination (Goodwin, 2005, p. 50).

Seward was extremely disappointed by his loss, but publicly supported the Republican ticket (Goodwin, 2005, p. 384). Lincoln was careful to mend this relationship, as he required Seward's active support for the presidential campaign. Lincoln recognized Seward's unique positioning at the national level, and Seward's perspective was considered as well as his ability to reach different groups of people. Seward went on an intensive speaking tour which was instrumental in securing Lincoln's Presidency.

Seward's transition from senator to cabinet member involved sacrifice and validated Lincoln to the Republican party, just as the golden fleece from mythology was born from sacrifice and was a symbol of authority. Seward also had extraordinary healing powers as he mended some

of the consequences of Lincoln's victory. After Lincoln's victory several states seceded, as a senator in Congress, Seward navigated the delicate situation on Lincoln's behalf. He directed several speeches toward the border states to slow the momentum of the South's secession (Goodwin, 2005, p. 440). The conciliatory tone of these speeches and resolutions he introduced in the senate cost Seward the respect of his more ardent antislavery colleagues. However, Seward believed working toward peace and representing Lincoln's policy points were worth the personal sacrifice of his views and reputation (Goodwin, 2005, p. 441). It was necessary to have a strong figure like Seward vocalizing and fighting for the ideas that Lincoln could not publicly say, as Lincoln had to appear to be more neutral. They were trying to keep states in the union and later, invite them back.

Lincoln relied on Seward for guidance and validation in all matters, but especially when addressing the demands of war like choosing generals. In the beginning when Chase and Bates would try to force Lincoln into acting on their opinions, Seward trusted Lincoln's "prudence, wisdom, and magnanimity" while respecting the limitations of with whom and on what Lincoln could work (Goodwin, 2005, p. 694). Once Lincoln recognized individuals' value, he relied on and defended them until they proved themselves unworthy.

2.7 A Reluctant Ally: Salmon Chase

Salmon Chase, who became Secretary of Treasury, served as a senator and governor for Ohio and was instrumental to the national Republican Party's formation (Goodwin, 2005, p. 27). In 1858, Chase campaigned in Illinois for local Republican elections, including Lincoln's senate race (Goodwin, 2005, p. 52). However, Chase's actions were not entirely altruistic as he was

known to have a serious case of "presidential fever" and believed "that he owed it to the country and that the country owed it to him that he should be President" (Goodwin, 2005, p. 43). Goodwin described him as overconfident, with a lackluster campaign, negligent in reconciling with past enemies, and yet shocked at the nomination outcome where he lost. Nonetheless, Chase begrudgingly congratulated Lincoln and Lincoln soothed his ego with high praise and request for assistance. Chase spoke in Ohio, Indiana, and Michigan, energizing voters in these pivotal states. Based on his willingness to help and his political prowess, Lincoln offered Chase a job as Secretary of Treasury (Goodwin, 2005, p. 382).

Unfortunately, Chase spent most of his tenure undermining Lincoln, and even enlisted his daughter Kate to create a "rival court" to the White House in hopes of catapulting Chase to the presidency (Goodwin, 2005, p. 629). While Lincoln always made the final decision, Chase spread rumors that Seward held huge influence and thus responsibility for the administration. Chase tried to force Seward out, but Lincoln listened and then advocated for Seward (Goodwin, 2005, p. 714). Lincoln tolerated Chase while he spread rumors, tried to oust Seward, and continued to undermine Lincoln because Chase was still doing a necessary job well. In the presidential election year of 1864 Chase made numerous attempts to garner supporters. As Chase made advancements, Lincoln's supporters mobilized, and thus diminished Chase's chances without Lincoln having to directly respond. Chase's presidential aspirations dissolved for the moment, but surged in the summer, and yet Lincoln continued to allow him to serve in the cabinet. Chase offered his resignation multiple times in attempts to gain more autonomy. He persistently attempted to fill positions as favors to friends, and his attempts were fracturing the Republican party. Lincoln refused to give Chase the complete autonomy he desired, so Chase offered his resignation for the fourth time. Chase expected Lincoln to decline once more and give him more autonomy. However,

Lincoln accepted Chase's resignation as Secretary of Treasury from the cabinet. While Chase was shocked and disappointed to leave, Lincoln casually mentioned to Chase's friends, Chittenden and Hooper, that even though their relationship had become strained, he would nominate Chase to Chief Justice of the United States if he got the opportunity. Lincoln recognized the shared aims held by Chase and when there was an opportunity, Lincoln nominated him for Chief Justice (Goodwin, 2005, p. 915).

2.8 Section One Conclusion

Lincoln's and Lysenko's disparate strategies for dealing with disagreement and difference can also serve as comparative case studies for other high stakes scenarios involving members of a team or multiple teams working in the same area or on the same issue. Dialogue across the political spectrum equipped Lincoln with knowledge and informed his perspective to advance Black rights in America. Lincoln's commitment to mending relationships, especially among his colleague-competitors, allowed him to integrate them into his cabinet, resulting in more of the country to be represented. When they competed for the presidential nomination, they were colleague-adversaries. When they were working together in court or campaigning for the Republican presidency, they behaved as colleague-allies. Thus, they moved on the spectrum of colleague-competitors.

In contrast, Lysenko, chose a different approach and viewed those occupying and representing different perspectives solely as colleague-adversaries. Rather than seeking to benefit from their different perspectives, he sought to eliminate differing perspectives and indeed those who held those different points of view. This was harmful to the scientific community, and those

applying these theories to their livelihood, such as the Soviet farmers and those that depended on them for food. As the next section will demonstrate through the analysis of Starzl's approach to team- and network-building in transplantation, this vocabulary of colleague-competitiveness — placed alongside the analytical theories of science, technology, and society studies and history and philosophy of science — helps to illuminate the importance of scientific collaboration between differently situated individuals and their respective communities.

3.0 Section Two: Starzl's Approach to Colleague-Competitors

Thomas Starzl, living in a different time and operating in an evolving field with different problems and goals, faced challenges that may seem similar to those faced by Lincoln and Lysenko. In the field of transplantation, Starzl adopted an approach to dealing with competitor-colleagues similar to that of Lincoln, desperate and determined to save a divided country. Lysenko had similar scientific goals as Starzl— including establishing a new field of research and improving lives— yet Lysenko's approach to colleague-competitors, among other factors, was key in determining his ultimate (strongly negative) political and scientific impact. Starzl had opportunities to behave like Lysenko, yet he chose a different approach.

The narrative examples drawn from primary and secondary materials from the Starzl archives and analyzed in this section demonstrate how Starzl's integration of differently situated individuals bridged different emerging transplant centers and their approaches. He accomplished this through his ability to form interpersonal relationships with his collaborators and to be open to their fluctuations along the spectrum between ally and adversary. Starzl built a cooperative international group of expert collaborators in tandem with his own research team. Instead of limiting himself to his sphere of current colleagues or using published concepts or his own research data, Starzl was an integrator of more broadly dispersed and disparate people and ideas. He invited individuals, their ideas and methodology, and respective institutions into conversations and collaborations in the face of international competition to be the first to transplant certain organs or innovate a particular process.

Historically, becoming the first person or group to accomplish a task is often preceded by fierce competition. The dialogue Starzl helped to foster between differently situated groups, like

members of a transplant team or transplant centers, allowed early transplant pioneers to rapidly adapt and develop successful procedures. Even though they were constantly competing, these early pioneers established a culture of data sharing and conversation which allowed for substantial advances in the field. Learning from each other's data in real time, such as past attempts to transplant a specific organ, saved effort and resources. This collaboration was crucial when incorporating new technology, like tissue matching or the FK-506 immunosuppressive drug, into a patient's evolving treatment plan. At each pivotal point, key interpersonal relationships heavily contributed to the innovation and its implementation. Later, as Starzl became a leader within this field, he trained new scientists who went on to establish their own transplant centers. Throughout this section, Starzl's interpersonal interactions will be analyzed using concepts and vocabulary introduced in the previous section.

3.1 Starzl as an Integrator

Starzl, almost certainly without knowing the social-scientific theories sketched above, combined differently situated individuals to create his transplant treatment team. He successfully brought together people representing different perspectives and disciplines ranging from physicians and surgeons to financial coordinators and social workers. Each individual supports the patient in a unique way while bringing a different perspective to the patient's care plan. This transplant team resembles the model of the modern healthcare team that has replaced the dyadic

models of physician-patient care. John Fung[2], a transplant surgeon who worked with Starzl, described this idea as novel when the field of transplantation was emerging and states that it remains popular in practice across different specialties, not just transplantation (Fung, personal communication, November 10, 2021)

In addition to building a team to work with on a regular basis and receive feedback from, he constructed his own network of colleagues within different fields, including transplantation. For the purposes of this paper, a "team" is a group one works with on a daily basis and with whom one has strong personal influence and connections whereas a "network" is a looser association of people with whom one might have collaborated with in the past and may or may not stay in contact. Alongside other early transplant surgeon-scientists, Starzl established a culture of data sharing and network building that harnessed the potential of individuals and institutions to propel the field forward. Starzl simultaneously considered the views of members of his team and less prominent transplant teams around the world. As the field of transplantation was materializing, he was instrumental in connecting people from different disciplines with each other to overcome the challenges associated with establishing this new procedure. Depending on a particular project, he could pull individuals from his vast network into his team. This integration of individuals instead of just their knowledge or methods involved forming interpersonal relationships among the differently situated individuals and resulted in the mutual exchange of ideas.

[2] A virtual interview was conducted with John Fung on November 10, 2021, and the transcript will be deposited in the Dr. Thomas E. Starzl, M.D. Papers. At the time of writing this paper, it is unavailable to the public.

To illustrate the integration of many differently situated individuals required to make transplantation successful, I created this topological process map in Figure 3.1. This simplified diagram depicts the relationship of key transplant team members.

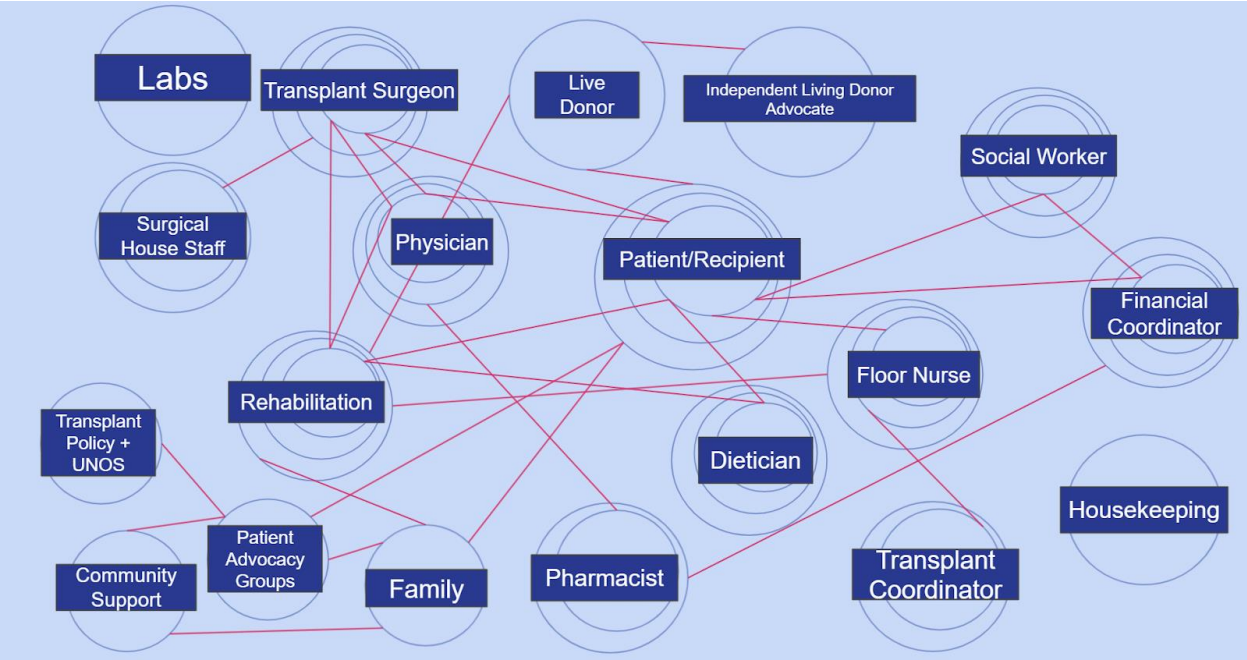

Figure 3-1 Transplant Process Map. Patients receiving a transplant rely on many individuals and groups prior to and after surgery. Various national and institutional policies, and standards of care, govern the placement of patients on a waiting list (based on factors such as survival benefit, medical need, and location), as well as the matching of patients with organs from living or cadaveric donors. The team members contribute different expertise when building a cohesive treatment strategy for each patient. The pink lines indicate direct collaboration while the innermost circle correlates with a higher frequency of collaboration.

3.2 The Early Pioneers

Prior to the 1960's and 1970's, few individuals attempted transplantation procedures as the idea seemed far-fetched. The first to succeed, however, would bring fame and fortune to their institution and, potentially save patients who had lost hope. Transplantation had been attempted for centuries, yet after the first successful modern transplant, it took innovators only a couple decades to transform these operations into common practice (Starzl, 2003). In the early years, there

were other individuals, like Starzl, who were pivotal in this transformation. Joseph E. Murray, a surgeon at the Brigham Hospital in Massachusetts, was the first to perform a successful organ transplant when in 1954 he transplanted a kidney between identical twins (Starzl, 2003, p. 87). In the following years, several others raced to complete the first transplant of other organs, or unique combination of organs. In South Africa, Christiaan Barnard conducted the first heart transplant, while in the United Kingdom, Sir Roy Calne worked to combat organ rejection by developing drug therapies (Starzl, 2003). Despite their trans-Atlantic competitive spirit, these early pioneers analyzed each other's data, communicated frequently, and trained with one another (Starzl, 2003).

Figure 3-2 Symposium for David Hume. At a symposium honoring David Hume in Richmond in 1974. Second row (L to R): fourth from left is Joseph E. Murray, fifth from left is Thomas E. Starzl, and second from right is Paul I. Terasaki. Third row (L to R): top right corner is Roy Calne (Starzl, 2003).

Murray was a medical intern working in Boston in 1944 and had performed skin grafting and plastic surgery while serving in the US Army medical corps (Shampo, 2001). When he returned to Boston he began his work on antirejection drug application for organ transplantation

(Starzl, 2003, p. 76). In 1954, Murray performed the first successful kidney transplant between identical twins (Starzl, 2003). While this success was ground-breaking, it was the result of the perfect tissue match that twins provided (Starzl, 2003, p. 87). However, future progress would require advances in different aspects of the procedure, most notably, in how the immune system would be suppressed to avoid or minimize rejection (Starzl, 2003, p. 87). Building on Murray's progress, several attempts were made beyond twins, but all patients developed fatal infections (Starzl, 2003, p. 88). By 1959, total body x-ray (irradiation) was used with the intention to weaken the graft recipients' immune system during transplantation attempts, yet was insufficient to facilitate a successful transplant in non-twin patients (Starzl, 2003, p. 88).

Even after Murray's ground-breaking transplant, it was clear that this point divided the history of transplantation and marked the beginning of its growth into the modern field known today. Murray's first successful organ transplant catalyzed interest, funding, and organization within the field (Starzl, 2003, p. 110). According to Starzl, the details of early transplantation efforts, which were mostly inconsistent and unsuccessful, were widely shared among the contemporary transplant surgeon-scientist community, thus providing valuable data for future progress (Starzl, 2003, p. 110). Murray created a worldwide kidney transplant registry in 1963 when less than 10 percent of transplant patients survived longer than three months (Starzl, 2003, p. 110). This collection of data in addition to existing dialogue between leading surgeon-scientists evolved into the establishment of transplantation societies, meetings, and journals (Starzl, 2003, p. 135). For example, the first symposium in 1966 on the medical ethics of transplantation was organized to provide a forum for discussing human experimentation and organ donation, which at that time was left to the discretion of physicians (Starzl, 2003, p. 145). Participants from around the world and from different occupations, such as surgeon, physician, and lawyer, were invited.

During this conference, these differently situated individuals applied their unique perspectives to address issues such as living donor abuse among individuals with an intellectual disability, ostracism within families upon donor refusal, and the use of captive donors like volunteer convicts (Starzl, 2003, p. 147). These communicative efforts were key in expanding collaborative relationships among colleague-competitors and promoted idea exchange. With every advancement within the field of transplantation, the number of individuals interested surged and then later declined.

Barnard worked in Cape Town, South Africa where he conducted the first heart transplant. Prior to this achievement, he had visited America to study heart transplantation in dogs in Richmond, organ rejection in Boston, and antilymphocyte globulin (ALG) in Denver (Starzl, 2003, p. 151). Barnard contributed to the science of liver preservation, and he worked to create a plan for heart transplantation by combining his own ideas with techniques and technology from the many transplant centers he visited and worked with. As a means of reducing rejection, Barnard applied ALG technology, adopted from Starzl for the first successful heart transplant in 1967 (Starzl, 2003, p. 152). Starzl used the Ackermann-Barnard machine to provide blood and oxygen to the organ and extend preservation time to the first successfully transplanted human livers (Starzl, 2003, p. 152). This give-and-take approach to transplantation knowledge promoted the flow of ideas to foster new advancements and was beneficial to all involved in the active transplant centers at that time.

Barnard, Starzl, Murray, and other researchers at this time frequently traveled and conversed with each other. They did not limit their analysis to published literature but sought out information from the active research teams that were studying patients, immunosuppressive drugs, and new technology like tissue matching. Had these early pioneers only used journal publications

as sources to influence their respective approaches, devise research studies, and treat patients, their projects would have been constrained by the effects of "positive publication bias" referring to the bias from the preference for publishing studies with positive results (Mlinarić, 2017). Failure to publish negative findings ignores ethical obligations in studies with human subjects who "have exposed themselves to risk with the assurance that the study is performed to benefit others" (Mlinarić, 2017). Starzl found a way to combat positive publication bias by encouraging conversation between his competing colleagues. There were numerous instances where data from a competitor was integrated right before or during pivotal drug trails or surgical attempts. This data sharing and mutual reporting of sometimes negative results, was crucial as the transplantation field expanded.

These early pioneers and their respective teams pumped new enthusiasm into the transplantation field with their successes and set the tone for a trans-Atlantic transplant collaboration. Following each wave of enthusiasm, eventually progress would slow and only a few individuals and their teams would remain actively conducting research for transplantation. These individuals and their institutions remained connected to centers around the world even while creating and maintaining their own, unique approaches for specific aspects of transplantation. The nature of an emerging field, such as the limited information and professionals, encouraged these growing transplant centers, often hundreds of miles apart, to adopt similar methods like inviting longstanding and new colleagues into their team.

3.3 Henry Bahnson and Pittsburgh

Henry Bahnson was a medical student with Starzl at Johns Hopkins thirty-five years before Starzl moved from Colorado to Pittsburgh (Starzl, 2003, p. 44). According to Starzl's own reflections in his memoir, Bahnson assisted Starzl in numerous ways throughout their respective careers including advocating for Starzl's position at the University of Miami, housing him when he moved to Pittsburgh, and serving as best man at his wedding (Starzl, 2003, pp. 43-44). In addition to Bahnson, it was Pittsburgh's transplantation program and approach that attracted Starzl from Colorado. His arrival resulted in Pittsburgh's quick transformation into a leading center for transplantation research and innovation. Bahnson was crucial in advancing both liver transplantation and the approval of cyclosporine, an immunosuppressive drug. He was known to be extremely talented, but also possessed "zealous integrity and fairness in coming to judgement of other people" (Starzl, 2003, p. 39). Bahnson's personal and professional qualities contributed toward establishing Pittsburgh's unique transplantation program that was conducive to the medical innovation that would ensue soon after Starzl's move to Pittsburgh.

In 1980, Starzl believed that liver transplantation could not progress in Denver because the leadership was not willing to support further experimentation at the level Starzl required (Starzl, 2003, p. 144). Starzl considered transferring to two centers where his friends from medical school were working (Starzl, 2003, p. 228). These two colleague-allies, Jim Maloney in Los Angeles and Henry Bahnson in Pittsburgh, both held leadership positions in established transplant programs (Starzl, 2003, p. 228).

Starzl first considered Los Angeles because of Jim Maloney, yet the UCLA hospital was only focused on kidney transplants and lacked sufficient resources (both intensive care facilities and blood bank support) to attempt liver transplants (Starzl, 2003, p. 223). The anesthesiology

department, among others, opposed attempting liver transplants as it was still controversial at this time. A group of surgery faculty also sought to block Starzl's appointment despite Starzl's intentions with the program requiring their support (Starzl, 2003, p. 223). Liver transplant's controversy and the lack of resources allocated towards experimentation in the transplant program made it clear UCLA was not the new frontier he had hoped it would be.

The individuals at UCLA belonged to the growing field of transplantation but valued their institutional goals and existing colleague-allies more highly than the potential advantages of broader collaboration. Instead of embracing Starzl as a colleague, with the potential to be an ally and adversary, they treated him as the latter. Starzl would have brought a potentially revolutionary cyclosporine-steroid therapy experimental trial and sought a better environment for this work (Starzl, 2003). He was concerned that the conflicting aims of the current UCLA staff and his arriving team would negatively impact the cyclosporine and liver trials, which in turn could harm his friend Maloney. After Starzl refused the position, Maloney protected Starzl and his reputation by not only "releasing him from his commitment to UCLA", but also corrected rumors that Starzl's appointment was withdrawn and forwarded paperwork to the University of Pittsburgh (Starzl, 2003, p. 228).

Shortly after Starzl decided against moving to Los Angeles, Henry Bahnson invited him to visit Pittsburgh (Starzl, 2003). During this visit, members of the transplant team, including the Chief of Urology Dr. Thomas Hakala, tried to dissuade Starzl from transferring to Pittsburgh because they had their own plans for the program (Starzl, 2003, p. 227). Hakala was using Starzl's 1963 double drug therapy with Imuran and prednisone, and patient survival resembled national standards; however, Hakala's team did not know about the new drug, cyclosporine (Starzl, 2003, p. 227). Hakala had already stated his intent to center the transplant organization within the not-

yet-established urology department and use it to generate an income (Starzl, 2003, p. 227). Starzl's arrival would halt those plans. Hakala told Starzl "to stay away from Pittsburgh. This [was] a small program, he said, in a mediocre school. No one knew or cared what went on in this little corner of the world, and he preferred it that way" (Starzl, 2003, p. 227). Even after this, and apparently in some ways because of it, Starzl said, "I liked him [Hakala] enormously. This was someone who could be believed if you asked a direct question. It was important to have this conviction later when it became my responsibility to decide on changes" (Starzl, 2003, p. 227). Starzl saw the potential in this colleague, who was viewing him as an adversary, to actually be an ally, in large part because of his honesty. He believed that Hakala, already using Starzl's published work, would not impede his appointment or obstruct progress. Starzl told Bahnson he could work with Hakala, and his outspoken or conflicting opinion would help Starzl make better decisions (Starzl, 2003, p. 227). In Pittsburgh, Bahnson was known to deal directly with concerns or issues, thus there was a consistent, open dialogue between important and differently situated individuals. While the teams in both Los Angeles and Pittsburgh had individuals with their own plans for their respective programs, Starzl felt he could produce knowledge more efficiently and with the least amount of resistance by working with the Pittsburgh team (Starzl, 2003, p. 227).

Starzl began working in Pittsburgh on January 1, 1981, and brought the revolutionary immunosuppressive drug, cyclosporine, as well as members from the Denver team including Shunzaburo Iwatsuki, who was appointed as Assistant Professor of Surgery (Starzl, 2003, p. 229). At that time, only four American cities had access to the drug which was previously successful in Starzl's Colorado trials (Starzl, 2003, p. 229). Upon the merger of approaches and individuals from Colorado and Pittsburgh, the Pittsburgh kidney program grew and performed three times as many transplants as prior to Starzl's move (Starzl, 2003, p. 229). Starzl said that "the newly arrived

Colorado team was a collective teaching machine, conveying what had been learned in Denver and converting information to therapeutic recipes that could be used in Pittsburgh and then exported around the country and world" (Starzl, 2003, p. 230). It was clear that this was a merge of knowledge through key individuals like Starzl and Iwatsuki, and it led to great advances in the field. The cyclosporine trials with kidneys were supported by the results from the Pittsburgh liver cyclosporine trials and Bahnsons attempts with the heart much later (Starzl, 2003).

Starzl's colleague-ally, Bahnson, paved the way for his move to Pittsburgh and established a culture amicable to Starzl. Bahnson's job entailed recruiting individuals from across the world. While there still was tension, Starzl valued the differing viewpoints and recognized these individuals as colleagues. He stated that they were not attempting to invade or take power, but merge and advance the field (Starzl, 2003, p. 229). This contrasted with the tone in Los Angeles, where the adversarial tensions threatened progress, especially regarding the cyclosporine trials. Bahnson had his own interests in performing more heart transplants, but recognized that others, like Starzl, would have to make advances in combating rejection with other organs first, and actively supported their efforts (Starzl, 2003, p. 225).

When Starzl moved to Pittsburgh he encountered some difficulties with scheduling transplant surgeries and accessing operating rooms and intensive care units (Tzakis[3], personal communication, November 29, 2021). Bahnson served a crucial role in navigating these challenges by creating space and recruiting personnel for the increased number of transplants. Starzl stated that "to make transplant work, surgeons must form coalitions with the physicians whose specialties

[3] A virtual interview was conducted with Andreas Tzakis on November 29, 2021. At the time of writing this paper, it is unavailable to the public.

are defined by organs: kidney (surgery and nephrology), liver (surgery and hepatology), heart (surgery and cardiology), and others (always involving surgery)" (Starzl, 2003, p. 246). Starzl formed coalitions with differently situated individuals to form the transplantation treatment team. Starzl's migration catalyzed Pittsburgh's transplantation success, contributing to the reinvention of an industrial town into a hub of medical innovation, referred to as a "medical metropolis" (Simpson, 2019). During this time, Starzl remained in contact with the different transplantation centers around the world and their leaders, such as Sir Roy Calne in Cambridge.

3.4 Sir Roy Calne, the Moonwalker

Sir Roy Y. Calne is another early transplant pioneer who advanced immunosuppression and surgical techniques alongside Starzl. The majority of his work was conducted in Cambridge, United Kingdom and he frequently collaborated with scientists around the world (Starzl, 2003. David Winter, who worked for Sandoz Corporation during their immunosuppressive drug trials, was a witness to Starzl and Calne's enormous impact, and referred to them as "moonwalkers" (Starzl, 2003). Winter had been responsible for the medical care of astronauts at the National Aeronautics and Space Administration (NASA) and went on to be instrumental in the Food and Drug Administration (FDA) approval of Starzl and Calne's anti-rejection drugs (Starzl, 2003, p. 211). "He knew how those remarkable people had been chosen who would walk on the moon and go other places where humans are not supposed to be" and went on to choose Starzl and Calne for important pilot studies of an anti-rejection drug called cyclosporine (Starzl, 2003, p. 211). Winter went on to say that these moonwalkers, like Calne, had determination and courage as the first principles, followed by intelligence and skill (Starzl, 2003, p. 190). Calne and Starzl helped

establish liver transplantation as a reliable procedure and developed anti-rejection drugs such as Imuran, cyclosporine, and FK-506.

Calne studied transplantation in Boston, where the first successful transplant occurred, and would go on to facilitate the flow of knowledge between Boston to Cambridge (where Calne would spend the majority of his career focused on kidney and liver transplantation as well as anti-rejection drugs) (Taylor, n.d.). In the early 1960s, alongside the surge in liver transplant centers around the world, Starzl and Calne's correspondence began (Taylor, n.d.). Starzl had a similar focus on kidney and livers, and together they developed their research centers and focused on anti-rejection drugs. Instead of waiting to read each other's publications in journals, they established a dialogue that bridged the two knowledge generating centers of Cambridge and Denver. Calne established the world's second liver transplant program and the first in Europe after hearing about Starzl's success in Denver (Taylor, n.d.). Not only were the data promising, but Calne knew he could rely on Starzl to obtain similar results (Taylor, n.d.). Starzl's breakthrough with liver transplantation prompted Calne to begin transplanting livers with a similar technique, thus providing still more data (Taylor, n.d.).

Starzl recognized Calne's role in transplantation innovation and research, stating that "the fate of liver transplantation would depend on an unspoken trans-Atlantic alliance between Cambridge and Denver without which further efforts could not have continued, much less succeeded, on either side of the ocean. These mutually supportive moral and scientific bonds pulled liver transplantation into the mainstream of medical practice" (Starzl, 2003, p. 190). Starzl and Calne established an important dialogical relationship early, which streamlined the flow of knowledge, allowed them to jointly identify patterns in their data, and quickly and more accurately interpret them. Early in their work with livers, they faced resistance from their respective teams

due to the risks, numerous variables, and inconsistent success rate of the procedure (Starzl, 2003, p. 189). When progress stalled in 1975, for example, Starzl sent tissue and clinical records to Cambridge and together they analyzed these early Denver attempts (Starzl, 2003, p. 188). The outcomes from the Denver cases' outcomes were slightly better due to use of ALG compared to Calne's attempts (Starzl, 2003, p. 189). At the time, Calne and Starzl were leading the only two liver transplant centers in the world, and they concluded that a safer and consistent antirejection treatment was required (Starzl, 2003, p. 189).

Prior to the use of anti-rejection drugs, the common practice was to use radiation to combat rejection, even with its toxic side effects (Starzl, 2003, p. 78). The new drugs would suppress the immune system and thus assist in reducing the body's rejection of the donor organ. In 1962, Calne and Murray developed and implemented the first chemical to combat rejection called azathioprine, which had the trade name Imuran (Taylor, n.d.). In 1964 Starzl's team produced the first lifetime survivor of liver transplantation in a dog with the use of Imuran. Across the Atlantic, stronger evidence from pig experiments was provided by Calne in Cambridge and other scientists in Bristol (Starzl, 2003, p. 133). The combination of these results strengthened Starzl's theory, and they continued to discuss their work and simultaneously try drug therapies.

In 1978, a new potential anti-rejection drug called cyclosporine was discovered by the Sandoz Corporation (Starzl, 2003, p. 209). Starzl justified why it would be people like him and Calne to implement drastic changes like new drug usage:

> [Calne] was just starting clinical trials in kidney transplantation with cyclosporine. It was too early to predict what would happen. We talked for a long time about the second and third waves of transplant surgeons who were resistant to change. Change, it seemed, would depend upon those who had opened the field. The professional risks were too great for younger surgeons whose careers could be ruined by deviation from 'standards.' This would be a job for risk-takers. (Starzl, 2003, p. 209)

These second and third wave surgeons joined the field after early pioneers like Starzl and Calne proved that transplantation could be a reliable practice. Thus, they would wait for individuals like Starzl and Calne to prove the effectiveness of cyclosporine before supporting its use. There was a limited supply of this experimental drug, and the first human trials in kidney transplantation occurred at Cambridge (Starzl, 2003, p. 210). Winter, working with the FDA and Sandoz Corporation, knew that who was involved in the studies was extremely important, as they would need to be adaptive and collaborative to succeed (Starzl, 2003, p. 211). Winter authorized use of the drug in Denver and Boston, and Starzl spoke extensively with the team in Cambridge and learned that the patients were harmed by the drug and that it did not fully control rejection (Starzl, 2003, p. 211). John Fung, another transplant scientist that would work with Starzl on another immunosuppressive drug, described when Starzl began working on cyclosporine.

> Roy Calne, is a really bright guy, so you know, never detract from what he's accomplished, but he also relegated cyclosporin to basically the trash can, and Sandoz, who made cyclosporine, was actually going to stop making it. (Fung, personal communication, November 11, 2021)

Boston and Cambridge had been using cyclosporine alone, but Starzl analyzed their data, and in doing so avoided wasting additional drug doses and harming more patients. Starzl was able to converse directly with his colleague-competitors and be productive, which was crucial as his efforts essentially saved cyclosporine for meaningful application in transplantation (Fung, personal communication, November 11, 2021). Based on Calne's early results, Starzl combined cyclosporine and steroids in the ensuing trial in a similar strategy used with Imuran, which performed better than administering cyclosporine alone (Starzl, 2003, p. 212).

Calne released a report with the results of kidney transplantations using cyclosporine shortly after Starzl began the Colorado cyclosporine trials (Starzl, 2003, p. 212). While the report did not provide new information for Starzl's team, it fueled the negativity from those who opposed

the Colorado trials because none of the patients had achieved normal kidney function (Starzl, 2003, p. 212). The kidney trials in Colorado that had begun prior to this report were largely successful, contrasting with the European and Boston trials, and indicated that Starzl's combined steroid and cyclosporine use was effective. Because of the building antipathy, Starzl left for Pittsburgh, and as a result, cyclosporine was unavailable for use in Colorado until it was released for general use in 1983 (Starzl, 2003, p. 213). Prior to this move, Starzl spoke directly with the editor of *Surgery, Gynecology, and Obstetrics* and asked for an expedited report on the positive results from the cyclosporine-steroid therapy (Starzl, 2003, p. 214). Winter had warned Starzl that the Sandoz Corporation might stop the drug trial, which prompted Starzl to push for this publication (Starzl, 2003, p. 213). This streamlined flow of information from Winter to Starzl allowed Starzl to quickly share important data with the rest of the field. It prevented rash or harmful decisions and facilitated continued progress. This publication allowed for two more American kidney transplant trials with cyclosporine in 1980 and by following Starzl's cyclosporine-steroid therapy, these two teams obtained positive results (Starzl, 2003, p. 214).

In 1980 at the congress of the Transplantation Society, Starzl began summarizing progress in liver transplantation by "paying homage to Roy Calne" saying that "his courage and persistence" allowed for a more hopeful address, in contrast to the usual "dreary recitations of problems and failures" (Starzl, 2003, p. 220). This difference was attributed to the combination of cyclosporine and steroids which was developed by Starzl and based on Calne's past work, and their early and limited success would serve as a catalyst for the emergence of new liver transplant centers around the world (Starzl, 2003, p. 221). Calne continued to improve upon antirejection drugs, for example, he pioneered the use of Campath, which was a more effective and less harmful drug that could treat and prevent rejection (Taylor, n.d.).

Even though Starzl and Calne were professional about their competition, they were still clearly competing, and a strong example of colleague-competitors (Fung, personal communication, November 11, 2021). There is no shortage of instances where they were in agreement, and worked as colleague-allies, as well as in disagreement, working as colleague-adversaries. When Starzl and several other prominent transplantation scientists like Bahnson were convincing the American government to approve transplantation as a reliable clinical practice so that the procedure could be financed, Calne backed them in their fight (Starzl, 2003, p. 245). Starzl, Bahson, and Calne wrote letters, talked on the phone, attended conferences, and worked directly with each other. They were each able to become the first to transplant an organ, or combination of organs while connecting leading transplant centers around the world.

3.5 Tissue Matching and "the American Lysenko Affair"

Dr. Paul Terasaki and Starzl began working together in the 1960's and remained close friends for the rest of their lives. Terasaki was one of the most frequently cited scientists in the world (Starzl, 2016, p. 1). He introduced the microcytotoxicity test which serves as the basis for tissue typing, identified antigens at the histocompatibility loci and their role in hyperacute rejection, developed the Terasaki-Collins kidney preservation technique, and developed polyclonal ALGs to treat rejection (Starzl, 2016, p. 1). At the International Transplantation Society Meeting in 1980, it was said that Terasaki's tissue typing events were among the four "most important historical landmarks of the preceding 20 years" (Starzl, 2016, p. 2).

Starzl marveled at Terasaki's impressive scientific impact and uncompromising integrity, especially remarkable in light of his early life unjustly imprisoned in a Japanese internment camp

during World War II (Starzl, 2016, p. 2). Despite what the American government did to Terasaki, he thrived, and Starzl calls him the "father of human histocompatibility matching, a genuine American hero, and my good friend" (Starzl, 2016, p. 2). Together, they established a new application of human histocompatibility matching in transplantation, which included tissue matching and forged connecting points within the evolving field of transplantation. Their work and ongoing conversation with other scientists is evidence of bridging epistemic chasms between points of knowledge generation. When complications arose, some in the form of resistance from other colleague-competitors working with tissue matching, Terasaki and Starzl's approach to dealing with these interpersonal dynamics fortified the flow and generation of knowledge, instead of blocking the flow of knowledge and destroying careers as in the case of those who disagreed with Lysenko.

Prior to working with Starzl, Terasaki had pioneered an antigen detection method where the antigens were proteins on the donor tissue with the capacity to initiate an immune response by the recipient (Starzl, 2003, p. 119). In 1963, many transplant scientists hoped that identifying these tissue antigens would assist in combating organ rejection (Starzl, 2003, p. 118). This led to the emergence of human histocompatibility research, and Terasaki alongside many others believed in the value of tissue matching efforts for future transplantation cases (Starzl, 2003, p. 119). Since the majority of kidney transplant survivors in the world were in Denver, where Starzl worked for many years, Terasaki traveled there to test his antigen hypothesis (Starzl, 2003, p. 119). He wanted to compare the antigens in patients with successful transplants with their donors and evaluate the relationship between the quality of the antigen match and the clinical outcome; "a positive correlation of good matching and good outcome would suggest that the antigens being studied were the crucial ones involved in rejection" (Starzl, 2003, p. 119).

In 1964, Starzl and Terasaki estimated the degree of antigen match using samples from surviving recipients and their donors (Starzl, 2003, p. 119). They noticed that the most trouble-free recipients had white cell antigens that closely matched their donor's white cells, and in fact many of the successfully transplanted kidneys were from family donors (Starzl, 2003, p. 120). Based on this promising data, Terasaki and Starzl proceeded with a matching trial in October of 1964. They accepted voluntary organ donations from convicts at the Canon State Prison, resulting in fifty to sixty choices for each patient. Even within the large, unrelated donor pool, it was difficult to find good matches, but the best match was selected. However, if potential donors were family members, then these matches were frequently complete (Starzl, 2003, p. 120). There was no difference in the recovery of "patients who received kidneys from relatively well matched versus completely mismatched donors" and the only instances of consistent rejection-free recovery occurred with blood relatives, who possessed a myriad of factors beyond antigen matching that could contribute to a successful transplantation (Starzl, 2003, p. 120).

Starzl and Terasaki continued to analyze the correlation between the quality of matching and clinical outcome while the industry of clinical tissue typing grew worldwide (Starzl, 2003, p. 120). Institutions within this industry assumed that matching was the silver bullet to solving rejection and thus received funding from the National Institutes of Health (NIH) and other government agencies (Starzl, 2003, p. 120). By 1969, Starzl was convinced that tissue matching was not the "boon" that they predicted it would be in 1964 (Starzl, 2003, p. 121). Within unrelated donors, tissue matching "had not been an important determinant of outcome" and within families, "it was only equivocally influential" (Starzl, 2003, p. 121). Especially because of Starzl's role in initiating and indirectly encouraging global tissue matching efforts, his report created a "furor" (Starzl, 2003, p. 121). Terasaki went on "to collect data on twelve hundred cases of cadaver kidney

transplantation from other centers", thus significantly increasing their sample size in hopes of finding evidence to support tissue matching efforts (Starzl, 2003, p. 121). Starzl recounted Terasaki's report at the Transplantation Society in The Hague in September of 1970 (Starzl, 2003, p. 121).

> I was in the back of the auditorium on the fateful day. Anxious and looking smaller than I remembered him, Terasaki walked resolutely to the podium and read his message to a huge and it seemed to me hostile audience. What he said was not only clear and honest - it was wise. He pointed out that what was more interesting than the poor correlation of matching and outcome after cadaver transplantation was the large and unexpected number of patients with very poor matches who had done well. When he finished, there was little applause. As he walked off the stage with serene dignity, I realized that I loved Paul as his friends must have loved Socrates. He was the symbol of integrity. (Starzl, 2003, p. 121)

At the moment where the majority believed in HLA antigen matching to provide an incremental advantage, "Paul [Terasaki] realized that it could be professional and political suicide to reveal the unanticipated findings. He did so anyway" (Starzl, 2016, p. 2). Terasaki reported the poor correlation of matching and outcome while pointing out the "large and unexpected number of patients with very poor matches who had done well" (Starzl, 2003, p. 121). It was crucial to reveal this information not only to practice scientific integrity, but because of the legislation being drafted to mandate matching prior to performing transplantation (Starzl, 2003, p. 121). Mandating a technique that does not provide the anticipated advantage would have been harmful. The study data "breathed life into the still struggling fields of liver, heart, and lung transplantation where most candidates could not wait for a well-matched donor" (Starzl, 2016, p. 2). These results implied something beyond the scope of their original hypothesis: tissue matching was not the only solution to rejection, and investment in drugs, treatment strategies, and surgical techniques would significantly advance the field of clinical transplantation (Starzl, 2003, p. 123).

After the presentation, Starzl began the trip home through London. He recounts an almost cinematic scene in Heathrow Airport.

> At Heathrow Airport there was a large bookstore with stacks of books separating the aisles so that browsers on one side could not see those on the other. What I heard fixed that moment in my brain to the smallest detail, including the book I had pulled out to examine. I knew the men talking. One was an official of the NIH agency administering the contract that was the main support of Terasaki's laboratory. The other was a military officer stationed in Washington who later left the service and became a department chair in a medical school. What caught my ear was Terasaki's name. The two were planning an emergency site visit to UCLA with the intention of discontinuing Terasaki's laboratory support. Paul's heretical report was not what they wanted to hear, and now the messenger must be killed. (Starzl, 2003, p. 122)

Starzl immediately called his friend to warn him and a few weeks later Terasaki called back to report the loss of funding ($400,000 per year) following the site visit in California (Starzl, 2003, p. 122). While Starzl was unable to directly defend Terasaki at this moment, Starzl's warning provided his colleague time to prepare for the visit. At certain points in their careers, it is likely that Starzl and Terasaki competed for the same funding and contracts, but in these moments of need, Starzl leapt at any chance to support his colleague and friend, Terasaki.

Terasaki continued to contribute to the field. The antibodies, not normally present in the blood, used in the antibody test he developed to measure tissue antigens had the ability to kill white blood cells (Starzl, 2003, p. 123). If the recipient possesses these antibodies, then the donor organ is destroyed quickly which is called hyperacute rejection. However, Terasaki pointed out a detection technique for these antibodies, called cytotoxic crossmatch, that involved mixing the serum of the prospective recipient with the white blood cells of the planned donor (Starzl, 2003, p. 123).

In early 1971 the two emergency tissue typing conferences held in Dallas and Europe provided further evidence to support Teraski's analysis. That same April, at an NIH transplantation policy commission in Washington, Starzl publicly expressed his outrage at the treatment of

Terasaki (Starzl, 2003, p. 122). A few weeks later, Starzl received notice of an NIH emergency site for his own center, and their largest grant was defunded (Starzl, 2003, p. 122). It appeared that Terasaki's report against a popular doctrine for tissue matching and Starzl's protest of the NIH's unjust reaction were both deemed worthy of censure through defunding. This collective government response bore an eerie resemblance to Lysenko's narrative where state power influenced science. Several years after these incidents that resulted in the closure of Terasaki's lab, a Colorado University physician stole a copy of the unexpurgated minutes of the 1970 site visit at UCLA and sent it to Starzl (Starzl, 2003, p. 124). This document starkly contrasted with what Starzl heard from members of the site visit team who had claimed to fight for Terasaki and preserve his lab. Starzl displayed some restraint by not publishing their names in his memoir, but was certainly dismayed by the actions of those he must have considered to be colleague-allies (Starzl, 2003, p. 124). For those individuals involved in the site visit, perhaps accurately described as colleague-adversaries, it seems that professional rivalries were more important than either advancing the field or scientific integrity.

When writing about tissue matching and the emergence of human histocompatibility matching, Starzl originally titled that chapter "The American Lysenko Affair" in his memoir due to the backlash received in response to their reports (Starzl, 1991). In a letter[4] to Starzl, his editor suggested that "Terasaki is not an exact match for Lysenko" and that tissue matching should be the chapter's focus (Kratch, personal communication, November 3, 2020). In the context of this paper, however, Starzl's account of Terasaki's treatment and the development of a new, pivotal

[4] This letter was obtained via email from Peter Kratch, the director at University of Pittsburgh Press. He found this letter in the book file for Starzl, specifically among the pre-publication materials.

component of transplantation is of value. Analysis of Starzl's approach when pioneering new aspects of transplantation must involve attention to his interpersonal relationships and thus to Terasaki's experience and Starzl's response. While the editor, and perhaps Starzl himself, viewed Lysenko as a relevant precursor to how Terasaki was treated, it actually appears to be the opposite. Starzl and Terasaki resemble the victims of Lysenkoism as they both suffered from a government's attempt to influence science. In both the USSR and the United States, unique thinkers could be subject to persecution to various degrees to preserve previous, inaccurate assumptions, with the result of varying levels of harm to scientific progress.

3.6 The Next Generation: There Was Always a Bench Space

Throughout Starzl's memoir, when introducing new colleagues, he frequently contextualized their role or involvement by discussing where they trained and under whom. These details illuminate how the individual's approach was influenced. This section will discuss three individuals involved with the development of FK-506, an anti-rejection drug: Andreas Tzakis, Satoru Todo and John Fung (Starzl, 2003, p. 304). All worked with Starzl and other important team members in Pittsburgh. Fung played a crucial role in the early trials for FK-506, which was subsequently used by both Tzakis and Todo to perform the first successful transplants of pancreatic islets and the intestine, respectively (Starzl, 2003). Their individual successes not only built on one another, but also required clear communication with external individuals belonging to different transplant centers. Fung describes the field when he, as well as Tzakis and Todo, joined the Pittsburgh team.

> Chip Koop, who was a surgeon general, put together a consensus conference and in 1983, the, basically, the Health and Human Services decided that liver transplantation was no longer experimental. So what that meant was that insurance companies had to cover it. So that was really the impetus for, by 1984, when all these people started coming, but at that time, most programs hadn't really evolved to even starting because they didn't have any trained surgeons. (Fung, personal communication, November 11, 2021)

The insurance coverage prompted a global interest in training transplantation professionals as transplantation could become a more reliable source of income for institutions and this coverage essentially verified it as a lifesaving technique. Fung describes where these aspiring transplant professionals trained.

> When FK 506 came around in, like 1989, there were probably around 35 programs in the country. There are now about 135… Those programs… most of them trained in Pittsburgh, there were a few people who trained in Minnesota, and the UCLA program, it just started in 1984. So there were really only a few programs. (Fung, personal communication, November 11, 2021)

Because Starzl entered the field at a crucial time and was instrumental in its transformation to a reliable procedure, Pittsburgh was one of the few places where transplant professionals could be trained. These professionals would take these valuable skill sets back to their home countries or institutions or to establish programs somewhere entirely new (Fung, personal communication, November 11, 2021). Tzakis said that Starzl "encouraged innovation", considered ideas from anyone on staff, and was brutally honest in his assessments (Tzakis, personal communication, November 29, 2021).

FK-506, a substance produced by a fungus that interrupts or prevents immune reactions, was isolated in 1986 by a team at the Tsukuba medical school in Japan (Starzl, 2003, p. 289). The founding chairman of the Department of Surgery at Tsukuba, Yoji Iwasaki, worked as a transplant fellow in Denver with Starzl on ALG, which was instrumental in Barnard's successful heart transplantation (Starzl, 2003, p. 288). Starzl implied that his relationship with Iwasaki made him aware of this new substance that became FK-506 when stated "the substance had not yet been

described in the scientific literature, and it was not available for investigation outside the Fujisawa laboratories (Starzl, 2003, p. 289). It would not be until years later that this drug would be presented and tested (Starzl, 2003).

In 1986, at a small session at the biannual meeting of the Transplant Society, after cyclosporine reports, FK-506 was introduced (Starzl, 2003, p. 289). Starzl attended this meeting with Dr. Satoru Todo who earned his medical degree in Japan at Kyushu University where brain death was not accepted and thus transplantation research was limited (Taylor, n.d.). In 1984, Todo left to learn from Starzl and actually began working as an unpaid research fellow. During the Transplant Society meeting, it was reported that rejection was prevented with promising reliability and safety, yet Calne, who was already conducting experiments with FK-506, was concerned about the toxicity based on his recent tests (Starzl, 2003, p. 290). This toxicity, as Starzl's team would go on to prove, was species specific, and Calne's experimental data was only from dogs (Fung, personal communication, November 11, 2021). Many individuals at this conference were eager to find a better replacement for cyclosporine, which had serious side effects such as damage to the kidneys (Starzl, 2003).

Starzl would again, similar to his approach with cyclosporine, analyze Calne's early reports on the immunosuppressive FK 506 and mount his own attempt. Fung emphasized the necessity for FK 506's development by describing the difficulties of cyclosporine (Fung, personal communication, November 11, 2021). "Cyclosporine required the presence of bile acids for absorption, yet at that time, part of the operation involved draining the bile ducts, and thus the bile acids, to verify if the liver was functional" (Fung, personal communication, November 11, 2021). This draining made it difficult to "get the drug at therapeutic level". Additionally, "cyclosporine came in this solution that" tasted like "dirt" (Fung, personal communication, November 11, 2021).

Due to the combination with steroids, there was facial brutalization, an unwanted cosmetic effect, in kids where their faces would change and become hairy, resembling the “Hulk” (Fung, personal communication, November 11, 2021). There was a need for an immunosuppressive drug with less side effects, use of steroids, and rejection.

Todo and Starzl visited Japan weeks after that conference to obtain FK-506. Todo’s Japanese background, nurtured by a Japanese medical school, was an asset in establishing a relationship with Fujisawa, the company producing the drug (Starzl, 2003). Fung states that the early data obtained by Starzl’s team on FK 506 and obtaining the drug itself, was a product of the direct relationship Starzl was able to form with Fujisawa (Fung, personal communication, November 11, 2021).

> Todo was a Japanese surgeon, and he approached the president of Fujisawa about getting the drug that Roy Calne had dismissed as being too toxic to test out in the lab. And so, we started testing it in the, in the culture, and then in small animals and then in larger animals. (Fung, personal communication, November 11, 2021)

Because Starzl had welcomed individuals from around the world, including Todo, he was able to use his professional network in moments like these. Fung emphasized that “at that time [Fujisawa was] a relatively small Japanese pharmaceutical company, and the impact of having a Japanese surgeon, and kind of working that relationship... [there] was no doubt that Todo's presence was critical in the, in obtaining it [FK 506].” (Fung, personal communication, November 11, 2021). In addition to this, Todo had invested multiple years to perfect his surgical skills while on Pittsburgh's transplant team, led by Starzl (Taylor, n.d.).

Starzl and Todo went back to Pittsburgh to test the drug with the help of Adriana Zeevi and other Pittsburgh cellular immunologists (Starzl, 2003, p. 292). Starzl writes of this innovative period in his memoir:

> With the tiny prize, Adriana Zeevi and the other cellular immunologists in Pittsburgh could test the drug, using minute and carefully rationed quantities in tissue culture experiments. Within a month, more drug arrived for testing. Thousands of transplantation experiments followed with rats and subsequently in dogs, monkeys, and baboons. Every Monday night a research conference was held. At first, eight or ten people came. By the end of 1986, the conference room could not contain the growing number which eventually was nearly one hundred, all waiting eagerly for weekly reports on the tissue culture experiments, an account of transplant experiments in rats performed by a pediatric surgeon named Noriko Murase, and the results from dog transplant experiments carried out by Todo. Each piece of new information added to the excitement. The drug was more potent than cyclosporine and did not seem prohibitively toxic. (Starzl, 2003, p. 292)

These Monday meetings are another example of how Starzl contributed to the emerging Pittsburgh program's culture. Not only were these meetings open to anyone in the Pittsburgh program, but anyone who was visiting. "A lot of it grew because, you know, as more and more information became available, we, our visiting surgeons, we had hundreds of literally, at any one time, around 100 visitors that were in town for, to learn" Fung elaborates,

> every Monday night from six o'clock, and would often last till eight, eight or nine o'clock… It was always after work and we never thought about going home on Monday nights, because we were just learning about the drug. So that's sort of how that worked out. And it was open to anybody. (Fung, personal communication, November 11, 2021)

Starzl allowed anyone, including visiting individuals from other transplant centers, to witness his process as he did not try to hide anything (Fung, personal communication, November 11, 2021). After Starzl's team had progressed in their FK 506 trials, they prepared to present at an upcoming transplantation meeting. Calne had already voiced his concerns that FK-506 was toxic and had additional evidence from other animals which he planned to present at the European Society of Organ Transplantation in Sweden (Starzl, 2003, p. 292). Starzl worried that Calne's cautionary reports, alone, would jeopardize Starzl's future work with FK-506, so he mobilized all three centers conducting research on the drug to present at the meeting. The experimental data from centers in Japan, Cambridge, and Pittsburgh were shared at a symposium arranged by Starzl prior to Calne's presentation (Starzl, 2003, p. 292). The combination of research data from different

research teams was enough to allow Starzl and his team to continue to work with FK-506. This is another example where one individual of the Starzl-Calne relationship would analyze the work of the other and take it further, often resulting in successful application in transplants. Calne was someone that Starzl worked with and valued, and even when they were behaving as colleague-adversaries, they were still able to combine their work and contribute to the field. Starzl and Calne initially disagreed on the use of this drug, and Starzl would work with the next generation of transplantation scientists to gain FDA approval and incorporate this drug into his transplantation plan.

When working to obtain FDA approval, Starzl's team addressed the "adverse reports from Cambridge" while summarizing their own (Starzl, 2003, p. 295). Starzl describes interactions with the FDA in a meeting prior to proceeding onto clinical trials (Starzl, 2003, p. 295).

> The stereotyping of government agencies could be exemplified by the FDA. No week goes by without a newspaper or television story about overregulation by the FDA that has prevented the orderly development of a drug or device, or about underregulation and release of an unsafe product. We were astonished at what we found. Each of the FDA scientists was an expert in his or her own right and understood perfectly what we had to report. When we finished, they pointed out the gaps in our research (mostly toxicology), what safeguards they thought would be necessary if clinical trials ever were to be considered, and how our work so far did or did not fulfill FDA requirements. They invited us to return when we had more results to report. (Starzl, 2003, p. 295)

The FDA scientists were experts drawn from several disciplines, and their situatedness allowed them jointly to provide insights on gaps in research such as toxicology, necessary safeguards for clinical trials, and unfulfilled FDA requirements (Starzl, 2003, p. 295). Members of the FDA team suggested that FK-506 be administered to first-time liver recipients who were in the process of rejecting their organ, even after receiving anti-rejection treatment such as cyclosporine, because these patients were facing death and had nothing to lose (Starzl, 2003, p. 297). During the initial attempts, an FDA scientist made the crucial suggestion of adjusting the dose, which prevented a

patient's death due to FK-506 overdose (Starzl, 2003, p. 297). Working with the FDA to approve new drugs is required, but Starzl's team seemed to not only comply, but appreciate the unique perspective of this group.

John Fung was managing these trials, which were mostly successful as rejection was prevented in seven of the first ten transplants, and the organs remained functional years later (Starzl, 2003, 298). Fung had a background in immunology and joined Starzl's team to investigate FK-506 (Taylor, n.d.). Fung described that his role "was to make sure that we navigated the regulatory role without getting into… legal problems, very regulatory problems" and this helped Starzl maintain the independence to develop the drug without feeling those regulatory constraints (Fung, personal communication, November 11, 2021). Drugs need FDA approval and that process usually involves several stages over the span of seven to ten years, but the Pittsburgh team combined phases and condensed this timeline to obtain approval in 1994 (Fung, personal communication, November 11, 2021). They were able to do this because "patients that were losing their [transplant and] they were dying" and their application of FK 506 was "life-saving combined with exploration" (Fung, personal communication, November 11, 2021). Based on their negotiation with Fujisawa and their own institutional Investigational New Drug (IND) application, only the Pittsburgh team had the right to develop the drug and by 1991 or 1992, they had "a pretty good idea how the drug was, what the toxicity was, how efficacy was" (Fung, personal communication, November 11, 2021). Fung elaborates on the quick success of FK-506: "less than two years after the drug was given for the first time in humans", Fujisawa applied for their own IND and began multicenter trials which was the "pivotal" phase three study (Fung, personal communication, November 11, 2021). Todo's Japanese connection and the Pittsburgh team's collaboration with different centers and agencies accelerated the development of a needed drug.

More than 30 years after Murray's successful twin transplant in Boston, the environment of the transplantation field, especially in Pittsburgh, was still described by Fung to be an "exciting time, there was so much to do… so much stuff to go around that… I don't think anybody felt like they were sacrificed [in terms of having their interests or contributions overlooked]" (Fung, personal communication, November 11, 2021). The culture was that "if you work hard, you get credit. If you didn't do anything, then nobody would go after you because there were… other people who [were] willing to do the work" (Fung, personal communication, November 11, 2021). The program's IND allowed them to explore other applications, such as for autoimmune diseases or bone marrow transplantation, and the Pittsburgh transplant personnel worked together (Fung, personal communication, November 11, 2021). Todo ran the animal lab and performed "hundreds of experiments" using "about a million dollars a year" (Fung, personal communication, November 11, 2021). This provided Todo with an opportunity to give other Japanese surgeons, among others, an opportunity to learn (Fung, personal communication, November 11, 2021). Tzakis was more involved in the pediatric patient population while Fung continued conducting research (Fung, personal communication, November 11, 2021). "There was so much work to be done. There were so many opportunities that, I don't think anybody felt… they didn't have an opportunity to do something novel" (Fung, personal communication, November 11, 2021).

Starzl describes Fung in his memoir as "a new breed whose talents allowed fresh ideas and technologies to force their way into the light as flowers do through cracks in concrete" (Starzl, 2003, p. 298). Fung worked, often with different departments at the University of Pittsburgh, to address many challenges, including understanding the drug's effectiveness, devising a measuring system, and packaging the drug (Fung, personal communication, November 11, 2021). One of these fresh ideas was the "mini transplant" models, tissue culture systems, developed with Adriana

Zeevi and provided insights on the drug's effectiveness within a few days instead of the usual months or years (Starzl, 2003, p. 298). To measure the drug, they had to develop an immunoassay while Fujisawa developed the antibody to use with it (Fung, personal communication, November 11, 2021). When they first got FK 506, it came in a bag, and they worked with the pharmacy school to create capsules (Fung, personal communication, November 11, 2021). Before Fujisawa began manufacturing capsules, the Pittsburgh program had to create their own capsules, which was initially a smaller quantity, but grew to generate around 10,000 a day for almost two years (Fung, personal communication, November 11, 2021). These partnerships exemplify the integration of different perspectives and skill sets to magnify and speed up progress.

Starzl was worried that media reports would affect the experimental trials in 1989 and the approval of FK-506 (Starzl, 2003, p. 300). Two important newspapers, the *Pittsburgh's Post-Gazette* and *New York's Times*, voluntarily withheld articles until the day after the British journal, *The Lancet*, published the results (Starzl, 2003, p. 300). This allowed Starzl's team to present the data and conclusions to everyone, instead of having a filtered version of the events narrated in the newspapers. These reports convinced most of the scientific community and the public that FK-506 was effective, and could continue with larger clinical trials; however, there was debate about the merits of randomized trials when one therapy was considered clearly superior while the other was considered worthless or dangerous (Starzl, 2003, p. 302).

During the national conversation on FK-506, Andreas Tzakis applied the newly developed technique from Fung and Starzl. Tzakis had graduated from the University of Athens School of Medicine in Greece in 1974 and trained with several centers in America before becoming a fellow with Starzl's team in Pittsburgh in 1983 (Taylor, n.d.). Tzakis confirmed that he "had a lot of

trouble catching up" when he moved and describes how Starzl noticed (Tzakis, personal communication, November 29, 2021). (Starzl, 2003, p. 295).

> He was brutally honest, in his assessments… he told me, on no uncertain terms, that I was not capable to ever do a liver transplant, in front of a lot of people. I think it was fair. Because with the capabilities that I had at that time… I could not have done it… but it was also a landing into reality. He didn't have to do that. He could have carried on, and let me go, believing that I could do something and ruin my life. But he didn't do that. He had the courage to just be straight about it. And then he appreciated the effort that I made. And he helped me develop my career. Dr. Starzl was the person that, more than anybody else, helped me advance my career (Tzakis, personal communication, November 29, 2021).

Tzakis said that being aware of Starzl's serious doubt "motivated [him] to do everything [he] could to catch up" and Starzl admired his work ethic. Tzakis was determined to improve and eventually became one of the best surgeons in the world according to Starzl (Taylor, n.d.). In 1990, Tzakis worked with a team that used the FK-506 anti-rejection therapy in the first successful transplantation of pancreatic islets onto a newly transplanted liver (Starzl, 2003, p. 304). The pediatric patient had an advanced malignant tumor in the liver and pancreas which were removed (Starzl, 2003, p. 304). The islets were the source of insulin, a hormone that controls blood sugar and thus prevents the development of diabetes (Starzl, 2003, p. 304). Transplanting the islets as free pieces to the liver instead of transplanting an entire pancreas spared the child from developing diabetes (Starzl, 2003, p. 304). This first successful islet transplant provided further evidence to support the effectiveness of FK-506.

In 1987, Todo applied FK-506 to intestine transplants. Prior to this attempt, cyclosporine was used during a liver and intestine transplant in a three-year-old child who later developed a white blood cell cancer and died nine months after the operation (Starzl, 2003, p. 306). This was significant progress from the dozen attempts made between 1967 and 1987 around the world (Starzl, 2003, p. 306). Several teams attempted a similar operation, and only one team in Ontario

achieved survival in a patient that exceeded nine months. The Pittsburgh team understood that patients were surviving when receiving an intestine and liver from the same cadaveric organ, but no one was able to successfully transplant the intestine as a single organ yet (Starzl, 2003, p. 307). Todo and a Pittsburgh team used FK-506 in animals and found it was more effective and easier to use to control intestine rejection (Starzl, 2003, p. 307). In 1990, the Pittsburgh team performed five successful small intestine transplants with four patients receiving new livers at the same time and one patient receiving only a small intestine (Starzl, 2003, p. 308). After Todo presented these results at the 1991 annual meeting of the American Society of Transplant Surgeons, it was clear that intestine transplants were now practical due to the combined success in Ontario and Pittsburgh (Starzl, 2003, p. 308).

Todo, Fung, and Tzakis joined Starzl's team at the same time and when it was growing exponentially. The field itself was competitive, but the Pittsburgh program itself was also a competitive space as there was limited funding and positions, among other constraints. Within any colleague-competitor relationship, there is that potential to pursue an adversarial approach. Fung described the space as competitive while saying that "Starzl demanded that we [they] focus and work together" (Fung, personal communication, November 11, 2021). Tzakis said that the scientists would often fill in for each other to ensure "nothing fell through the cracks" (Tzakis, personal communication, November 29, 2021). The competition at this time was rarely prohibiting their work, and Fung cites his own "ignorance" of competition as well as Starzl's command to prioritize collaboration (Fung, personal communication, November 11, 2021). Starzl implemented structural changes to promote collaboration such as funding the creation of the Biomedical Science Tower (BST) open lab in 1988 (Fung, personal communication, November 11, 2021). Richard Simmons, who had just become the Chair of Surgery after Henry Bahnson retired, suggested the

open lab model and Fung was entrusted by Starzl to plan it (Fung, personal communication, November 11, 2021). Traditionally, researchers and their teams would have their own labs and equipment, like microscopes or PCR machines, but the open lab model provided everyone access to the same core facilities and was able to accommodate at least twice as many investigators than what that space normally could (Fung, personal communication, November 11, 2021). There were fewer physical dividers, and these walls were often transparent (Fung, personal communication, November 11, 2021). This design worked well and is popular in many academic centers (Fung, personal communication, November 11, 2021). Fung said that "we were always welcoming, we took anybody who was interested in working with us... there [was] always a bench space somewhere" (Fung, personal communication, November 11, 2021). The BST open lab is one of many mechanisms Starzl used to connect and draw people into his circle of interest where if they invest effort and thrive, he would nurture and provide opportunities, just as he did when asking Fung to design the lab (Fung, personal communication, November 11, 2021).

Even thought there were intentional efforts to promote collaboration among the various research teams, there was still some friction, and a source of discomfort was the composition of the transplantation personnel, specifically fellows, in Pittsburgh as there were “two or three international fellows for every American” and this divided “the work group… [into] two camps” (Fung, personal communication, November 11, 2021). Because a license is required to take care of patients, the American fellows “were relegated to… taking care of patients and a lot of surgeons from overseas… didn’t take care of patients, so they could go to the operating room” (Fung, personal communication, November 11, 2021). Fung says that some of the American fellows harbored “ill will” as they wanted to perform more surgery, but “a lot of that sort of went away as the volume picked up” (Fung, personal communication, November 11, 2021). By the time Fung

arrived in Pittsburgh and when the FK 506 trials began, they "had so many cases, we couldn't get anybody to scrub because everyone was tired" (Fung, personal communication, November 11, 2021). Withstanding these minor, or sometimes major, inconveniences required the mindset of a colleague-ally, where each individual recognizes how critical their contributions were and to focus on their shared goals, instead of their self-serving interests.

Around 1992, Starzl selected Fung to be the director of the Pittsburgh program and Fung said it generated a little bit "of resentment among the other fellows which did not linger for long" because Fung "was the youngest of all his [Starzl's] fellows at that time" (Fung, personal communication, November 11, 2021). After taking on administrative responsibilities at Pittsburgh, Fung was recruited to be the Chairman of the Department of General Surgery at the Cleveland Clinic in 2004 and hired Tzakis to work there as well (Fung, personal communication, November 11, 2021). Fung quickly grew their small transplant program from 20 to 150 transplants a year by the time he left (Fung, personal communication, November 11, 2021). Drawing on his residency experience in Rochester, he reformatted the entire Cleveland Clinic educational program (Fung, personal communication, November 11, 2021). He did so by integrating the different residency programs in the city so that junior residents could rotate and learn the "bread and butter surgery like hernias and breast biopsies, etc." before returning to the "mothership" or main hospital to finish their training (Fung, personal communication, November 11, 2021). Growing into the largest residency program in the United States was "fun" but the accompanying administrative tasks siphoned time away from operating (Fung, personal communication, November 11, 2021). Fung returned to where he attended medical school, Chicago, and devised a new, multidisciplinary transplant model that he made some progress in establishing at Pittsburgh, and progressed even further in Chicago (Fung, personal communication, November 11, 2021). In 2016, he was recruited

to be the Director of the newly created University of Chicago Medicine Transplantation Institute (Fung, personal communication, November 11, 2021).

Fung was not the only one to leave Pittsburgh, and he said that "a lot of the foreign doc's that we had… even if they became faculty and practiced in our group, eventually went back to their own country" (Fung, personal communication, November 11, 2021). This interpersonal flow of knowledge would profoundly impact transplant centers as well as usher in larger, structural changes. In 1994, Tzakis became the Professor of Surgery at the University of Miami and became the founding director of the Miami Transplant Institute in 2006 (Taylor, n.d.). Todo returned to Japan in 1997 as the Chairman of the Department of Surgery at the Hokkaido University School of Medicine "to work for the many patients in Japan and other Asian countries who have been waiting for a second chance at life from organ transplantation" (Taylor, n.d.). In addition to his transplantation expertise, Todo brought back the American training system to Japan. The European and Japanese systems resembled an apprenticeship model where a student learned the expertise of one professor and narrowed into a smaller group of people. After the Flexner Report, the American model became a structured progression where junior residents have a similar experience, acquire more responsibility and independence, and move forward to independent attending physicians. Fung states that Todo was "partially successful in Japan [even with receiving] ... a lot of pushback by the old guards" (Fung, personal communication, November 11, 2021).

The success of the FK-506 trials and direct application to previously "forbidden" organs paved the way for widespread adoption of organ transplantation (Taylor, n.d.). Fung contrasts the outcomes of patients throughout these years, starting with the application of cyclosporine (Fung, personal communication, November 11, 2021). "At that time… three out of ten patients died after the first, by the first year. By the time we got FK 506 on board, it was about two out of ten patients

would die in the first year" (Fung, personal communication, November 11, 2021). Fung recognized that the development of new drugs for infection treatment and new technologies for detecting infections as well as advances in critical care, blood banking, and anesthesia "contributed to the improvement in survival rates, but clearly FK 506 was a big deal" (Fung, personal communication, November 11, 2021). Todo, Fung, and Tzakis who all started out as young fellows working with Starzl's transplant team went on to become leaders of the next generation of transplant surgeons (Taylor, n.d.). In a departing letter to Starzl, Tzakis wrote, "Alexander the Great once said of his teacher: 'To my father I owe my life..., to my teacher I owe my good life…' I am in eternal debt to you" (Taylor, n.d.). These past students of Starzl were crucial in the FK 506 trials and went on to bring aspects of one of the earliest transplant surgeon-scientist's approaches to the next stages of their respective careers.

3.7 Section Two Conclusion

Starzl's intentional integration of individuals into his research and the field of transplantation propelled transplant innovation. With each major advance, such as tissue matching or immunosuppressive drugs, Starzl facilitated conversation between the leading knowledge generation centers of the field. He recognized environments that were suitable for collaboration, which was influential in his choice to move to Pittsburgh. He was able to overcome competition and navigate instances where colleague-allies, such as Calne, temporarily morphed into colleague-adversaries, and vice versa. Making data available frequently, regardless of the consequences as seen with Terasaki and tissue matching, through meetings and publications helped the field focus their resources effectively. In challenging moments, such as the tissue matching backlash, his

colleague-allies helped him through. Starzl's willingness to work with others and train new individuals resulted in the growth and dissemination of his approach, which was entwined with the Pittsburgh program.

While there were several factors, such as different and often less restrictive research protocols, that benefitted Starzl and other early pioneers, Starzl's approach to dealing with colleagues who are potential allies and adversaries can be applied by future scientists. In the next section, lessons from Starzl will be synthesized with modern pre-professional students' experiences in a competitive environment.

4.0 Section Three: What Health Science Students Can Learn from Starzl's Approach

These lessons from Starzl, Lincoln, and Lysenko are salient wherever knowledge is generated, imparted, and acquired, including at the undergraduate level. Indeed, the lessons are especially important at the beginning of an educational or training program when individuals are being exposed to new power structures and are developing their interpersonal skills relating to their pre-professional colleagues. Students entering these power structures have the potential to be colleague-allies or colleague-adversaries, and may serve as either at different times or with regard to different colleagues. Thus, it is important for students to develop an approach to managing competition and collegiality that respects and makes productive use of the different perspectives of differently situated individuals. In this concluding Section, I show how young scholars, especially students in STEM disciplines, can learn from Starzl's example and develop a method to integrate colleague-competitors into one's personal circle.

In the science-heavy disciplines that are marked by fierce competition, students frequently face internal and external challenges, like self-doubt or peer rivalry. They would be well-served by devising their own strategies for adapting to competitive situations. In instances of discomfort or adversity, it is important to develop an approach that facilitates the creation of meaningful support systems alongside professional networking. According to colleagues of Starzl, he was not just a passionate communicator of his own ideas, but able to forge new connections within a network of ideas. The lessons exemplified by Starzl's approach can be applied to anecdotes drawn from current pre-professional education to demonstrate how it is fruitful to accept the potential for colleagues to evolve into allies, instead of regarding them as adversaries and excluding them from a potentially collaborative learning process.

In what follows, I will demonstrate how the concepts identified in this paper can be useful in adapting to challenging colleague-competitor situations in the undergraduate educational experience. I will provide examples of evolving colleague-competitor relationships from my own experience as a pre-professional college student. These experiences will characterize different types of relationships and illuminate how they resemble colleague-ally or colleague-adversary approaches. Almost every day I face colleague-competitors, but starting a new era of academic endeavor, such as a new school or major program, was when I had great potential to form colleague-competitor relationships. These time periods were exciting and daunting as they included new expectations from faculty, new experiences with peers, and new challenges from classes. I was especially challenged when navigating extracurricular power hierarchies, research lab structures, introductory STEM courses, and higher-level STEM courses. To establish that my experiences are not idiosyncratic, I begin by discussing an initiative by STEM faculty that was designed to address some of the problems that my experiences then illustrate.

4.1 The Professors' Initiative

The terms colleague-ally and colleague-adversary are applicable in different fields and occupations, including at the training or entry level of a work project or educational program. In large introductory science courses, for example, most students will recall hearing a variation of the phrase "look to your left, look to your right, one of you won't be here in the next semester" (Chawla, 2020). This phrase foreshadows the challenges to be overcome in order to occupy the limited positions available for the successful. Students compete in both overt and subtle ways like monopolizing precious office hours or displaying contempt when asked to share study materials.

These signs of competition contribute to a daunting and isolating atmosphere in which students feel they must fight to survive. Forming peer relationships is necessary, especially in this environment created by educational institutions, as such relationships allow students to grow, nurture others and their own curiosity, and thrive.

During the recent pandemic, physically distancing oneself was necessary, these measures resulted in social distancing as well. Understandably, this prompted feelings of isolation, and most people can attest to the negative impact of such feelings on their productivity and health. These same feelings of fear and isolation, even when rooted in different institutional or environmental causes, can cause a similar effect. Recognizing the isolating effect and detrimental impact of traditional education approaches, professors around the nation implemented programming or changes to their curriculum to improve the student experience. For example, a group of first-year science professors at the University of Pittsburgh used a class exercise, Ecological-Belonging Intervention, both to normalize student struggles associated with transitioning to college and establish a more collaborative and productive culture (Pittwire, 2021). The intervention involved forming small groups of students for the entire semester, discussing challenges unique to first year undergraduate students, and asking students to write about their transition experience from high school to college (Pittwire, 2021). "Immediately after, students hear quotes from graduating seniors… —such as one by a white male biology major saying he was afraid he wouldn't do well in the course and a quote from a black female neuroscience major saying the process gets better—[which] were designed to challenge stereotypes and show that students from all backgrounds enter the course with similar concerns" (Pittwire, 2021). Students discussed within their small group afterwards and continued to meet with their groups throughout the semester (Pittwire, 2021). This intervention was designed to create a shift in academic culture. It resulted in "students from racially

ethnic minority groups and women" feeling more "engaged in group conversation and problem solving [,] and those students now feel like it's a safe environment. They're willing to actively participate without feeling judged" (Pittwire, 2021).

The intervention was adopted at other universities, and the professors' findings were published in the Association for Psychological Science (Turetsky, 2020). The paper states that "whether or not students can endure weed-out classes has less to do with innate ability and more to do with their frame of mind and social connections with their classmates when starting a rigorous new course of study" (Turetsky, 2020). This feeling of connectedness with peers is conducive to creative imagination and knowledge acquisition; I personally enjoyed and excelled in courses where I was presented with opportunities to form connections with peers through recitation sections, office hours, or group projects. These social ties assisted in my ability to excel, and cross-sectional analysis has shown they are integral in overall school retention (Turetsky, 2020).

Addressing the challenges associated with transition into a new physical or metaphorical space in which individuals are expected to create and problem solve together, such as an educational program, can employ formal interventions or structural changes in programming. However, addressing these challenges also involves individuals reflecting on their personal mindsets. Faculty participating in the intervention outlined above mention that a critical aspect "is for instructors to believe that every student is capable of passing their class" (Pittwire, 2021). This involves appreciating the potential of each individual student. Similarly, students themselves need to consider the potential of their peers. Undergraduate science courses are only one type of competitive space within the larger educational ecosystem. To be successful, students — especially pre-professional students — need to aspire to excellence in other spaces, such as extracurricular activities. In all these instances, students will benefit from entering these spaces

with a mindset that appreciates the dual potential of their colleague-competitors — namely, their potential to be allies, as well as adversaries. Adopting this mindset, combined with other conscious efforts, such as program- or class-level interventions, will help students surmount the feeling of isolation and intimidation that so often accompany competition and result in an improved competitive experience.

4.2 Movement Toward Allyship in the Classroom

After two semesters of introductory STEM courses and labs, I had realized the benefits of building rapport with classmates, often to make the class more enjoyable and manageable. My efforts were usually rewarded by the formation of study groups, and it was clear that many students were willing to invest in each other for their mutual benefit. Discussing assignments, sharing notes from missed classes, and sharing professors' advice obtained in office hours are some examples of how these relationships were conducive to actions that, in turn, increased the likelihood of performing well in the class. However, there were still individuals in these courses who took an adversarial approach and were competitive without being collaborative or who were interpersonally. During my second year, I embarked on higher-level STEM courses specific to my major program. One course in particular, Anatomy, covered an overwhelming amount of material and employed open-ended exam questions. It seemed that my peers were effortlessly excelling in the course, but as time went on, I realized that they had developed stronger studying habits than I had.

After performing poorly on two consecutive exams, I swallowed my pride which was rooted in my past successes and asked for help from both the professor and my peers. The student

I approached took color coordinated notes, sat in the front row, answered questions from the professor, and had a printed study guide ready a week before the exam; I knew she was thriving in the class. While we practiced identifying muscles in the lab, I inquired, “how are you preparing for this exam?” She shrugged her shoulders and replied, “I have no idea; there is so much material!” She was only partially honest. There was an enormous amount of material covered on each exam, yet she did have an idea. She was scoring the highest on almost every assignment, and I personally witnessed her expert notetaking and ability to answer almost every question in class. I entered this program a year earlier than the majority of my peers, and in retrospect, I realize that she likely thought that her skills of retention and notetaking were basic academic skills that everyone possessed. This is an excellent example of how someone with more power — someone with a bit more seniority who was excelling academically — universalized her knowledge because she did not realize that it was a situated knowledge born of her particular experience as a slightly more advanced student. Having attained a position of relative social power, she forgot what it was like not to be in that position. She would of course become slightly antagonistic towards others who she assumed should know those “basic” skills. Nonetheless, I was frustrated that she responded in such a dismissive way.

Her unhelpful response in Anatomy, a course that everyone in the major program takes their first semester, was surprising. I expected this response from someone in my Honors Physiology course, which I was taking that same semester. Taught in the basement of the biology building, half the class would congregate outside the classroom door, and the front three rows were filled with students. There were small cliques of friends, but each student held a serious expression mixed with different combinations of disgust, fear, or determination. The professor teaching this course held an influential position in the medical school and many pre-medical students took the

course hoping to obtain a strong recommendation letter. I later learned the professor was more than willing to write anyone a letter, but the strength of it remained a variable.

The combination of a class consisting of mostly pre-medical students and the fact that it was a curved class, made the course feel like an extremely competitive environment, even though the curve was supposed to be helpful to students by making the required level of attainment relative to the student group's mastery of the material. In reality, curving the class made it seem that every student's point of success raised the bar for every other student. Instead of reducing pressure to not requiring us to strive for a perfect score, curving the class made it feel somewhat like a zero-sum game. Every student's success made it harder to achieve an adequate piece of the academic pie. The average of the class was curved to barely an A minus, and most students wanted an A. The first exam had a sixty-eight percent average, while the second exam had an eighty-nine percent average, and both were rounded to a ninety.

Years later I formed a friendship with a past student from that same section, and she explicitly stated that she barely remembered me, but assumed I was one of *those* overachieving pre-medical students. Ironically, I had assumed the same of her and distinctly remembered that she flashed me what I thought was a glare, but apparently, she was constantly stressed and not intending to communicate anything towards me. Students might believe that their classmates are determined to get a better grade and might be strategizing ways to surpass others, but that is not always the case. We were both concerned in our ability to succeed in this rigorous course and had more in common than we previously thought.

The culture of curved classes is naturally more competitive, yet students might bring their approach from these courses into other courses or spaces. The student in Anatomy seemed to practice a colleague-adversarial approach that may be advantageous or necessary in a curved class,

but was entirely unnecessary in Anatomy, which was not graded on a curve. While the Anatomy course still had some competitive components, such as competition for the limited attention of the professor or for obtaining recommendation letters, our grades did not interact with one another. In my desperation, I approached the Anatomy student again, as she was in the same, smaller Anatomy lab section as me. I asked if she would be willing to share study guides, while warning her that mine was not nearly as impressive as hers. Surprisingly, she agreed. Transactional exchanges like these were the extent of our working relationship, and I was disappointed that we did not directly study together or become friends.

While this colleague-competitor shifted toward ally, there still existed an underlying competitiveness and expectation, that at any moment, we would become adversaries. However, entering competitive spaces does not require immediately putting up one's guard. Students practicing an adversarial approach may be unaware of it. It may be something they modeled from past interactions or be a product of the "system," the institutional and privileged pipeline of students from upper class or resource-dense school districts. I developed an empathy for adversarial students. After learning from Starzl's approach to colleagues, I will initiate conversations much sooner with students in my courses, especially those from different backgrounds. I was used to collaborating with individuals I liked and that also happened to have a similar mindset. However, individuals with different approaches, regardless of their likeability, are important to converse with to better understand challenges and routes to overcome them. I now recognize that those who appear to be in competition can still be collegial.

4.3 Authorship

It is common for students with an interest in graduate school, and especially advanced healthcare education, to become involved in research. I attended a large, research-intensive university embedded in an urban area which included a myriad of professional graduate schools and large health networks. All of these opportunities attracted students with aspirations that required them to carve out a focus for their individual scholarship or empirical research. As students try to position themselves to take advantage of these resources and become strong candidates for their next step, such as graduate or professional school, they are often operating within competitive spaces.

In the neurophysiology lab, the first laboratory I joined as a second-year, for example, I was determined to stand-out and contribute notably to the project. There were several second- and third-year undergraduate students that joined around the same time I did, and one student was in my class which was taught by the Principal Investigator (PI). In this course, I struggled to excel at the same level as this other student, which felt like the appropriate standard. Within the course and laboratory settings, this student seemed to be a clear favorite as he spent the previous summer conducting research in the laboratory. I heard from another student in the lab that the PI preferred to mentor male students and there was circumstantial evidence supporting this rumor as there were no female students in leadership positions or even as upperclassmen or graduate students (it eventually emerged that this rumor was incorrect). Witnessing this student interacting with the PI combined with my experience working in this male majority space, exacerbated my suspicions that I would not thrive there and that favoritism and laboratory politics would steer crucial decisions that would affect my future success. One such decision was determining authorship on manuscripts coming out of the lab.

While obtaining a research position is a notable achievement, being acknowledged on a publication is a priority. A publication, but specifically as first- or second- author, can launch a scholar towards their desired career path or education program. As a second-year, I had limited understanding of the research process; however, I focused on my pre-professional goals, specifically authorship. At the time, I felt that favoritism and other external factors would restrict me. On one paper, I received an acknowledgement, while the male student I believed to be favored was listed as an author. It was also understood that he would be first author on the next publication. Later I realized that this student earned roles with responsibilities that led him to make contributions warranting these authorship spots.

This student had more than longevity in the lab; he frequently adjusted the protocol, collected data in every phase of the project, and analyzed several types of data. He excelled at these responsibilities due to his unique skill set and frequent attendance, resulting in him being present when these tasks were available. These experiences, as well as his role in training new lab members and taking other initiatives within the lab, resulted in his responsibility to draft the upcoming paper. This work, not his close relationship with the PI, meets the criteria for being first-author ("Defining the Role of Authors and Contributors", n.d.). Because this work was done openly and everyone was invited to weekly lab meetings, we could witness each other's contribution and perspectives. Identifying our roles in the paper was done openly whereas other programs might resort to more secretive practices like halting communication between those who are no longer authors on the paper (Grove, 2020). In my earlier undergraduate years, I would have not only desired, but felt deserving of a first- or second- authorship position. My time in the lab overlapped with my work in the Dr. Thomas E. Starzl, M.D. Papers archives. Because of what Starzl modeled in terms of colleague-competitor collaborations and because of the transparency of

the process in the lab, I came to understand the different contributions made by lab members and realized what was required to become a first author. I realized that I could become one, if I work towards meeting the criteria.

4.4 Fellowships

There are situations where other's achievements reduce the likelihood of attaining one's own goals. An example of this at the undergraduate level are competitions for scholarships or fellowships, which can provide monetary support for extracurricular experiences. In most cases there is a limited number of these awards, creating a structural problem which prompts an adversarial response. During my time as an undergraduate, I have participated in cohorts vying for different fellowships and scholarships. These award competitions often seek to compose diverse and multidisciplinary cohorts, and thus it was likely that in a given award cycle, only one of us could receive internal, university or external support for our laboratory specific proposals. This competitiveness prompted me, during my second-year, to propose different projects for these fellowships that I knew my fellow research assistants were applying to. In considering the lessons learned from Starzl, specifically to present one's own data and ideas, and integrate others when possible, I decided to apply for these fellowships that our laboratory often received. The laboratory manager was more than willing to support my application and past recipients, still conducting research, were willing to provide feedback on my proposal. My understanding that colleague-competitors operate on a spectrum and that at least some of my peers would likely move towards colleague-ally whenever possible, allowed me to take advantage of their expertise and earn a fellowship for this research experience.

The individuals in this research laboratory were in different career or educational stages, yet a majority were working towards medical school. When groups of us would apply, and there would be a disparity in the number of interviews and acceptances, we would still converse with one another and support each other. Our colleague-ally approach manifested in emotional support throughout the process, as well as practice of interview questions. My peers understood that in these instances where there are a limited number of spots, such as for grant funding or medical school, we were competing with so many individuals, many of whom we would never meet. Like Starzl, we chose not to use a colleague-adversarial approach with those colleague-competitors we knew were participating in the competitive space. We recognized that taking an adversarial approach would undermine our overall success by shrinking our support network and reducing our opportunities to learn from each other. Pre-medical students have the stereotype of being extremely competitive, partially due to the requirements of medical schools. Nevertheless, because our lab team spent years working towards a shared goal, we were all aware that even in moments of competition, we were still colleagues and would likely return to being colleague-allies very soon. This resulted in a collaborative and nurturing environment, as well as genuine friendships.

4.5 Section Three Conclusion

As demonstrated by my experiences, it is possible for students — even undergraduates — to experience movement along the colleague-competitor spectrum. In the Anatomy course, a higher-level STEM course, direct efforts moved a relationship in smaller intervals towards allyship. In the research laboratory, we were able to navigate competitive opportunities such as authorship, fellowships, and laboratory responsibilities while forming interpersonal relationships

that transcended the professional setting; we spent time together and supported one another. With regard to fellowships, individuals may transition from competing with one another during the application process, although distanced or unaware of each other, to being welcomed into a collaborative space. In all of these situations, I was initially alarmed to find myself without an approach to dealing with competing peers while trying to learn a body of scientific knowledge and even make some discoveries of my own. In retrospect, I realize that I would have benefited from implementing lessons learned from analyzing the approach Starzl took when trying to overcome scientific challenges. Adapting lessons from his experience would have led me to feel more confident in having a strategy to collaborate in seeking solutions, even collaborating with those who were also competing to achieve the same goals. Lessons drawn from analyzing part of the Dr. Thomas E. Starzl, M.D. Papers, coupled with insights from feminist epistemology that support seeking the perspective of people from different backgrounds with different approaches were helpful in reflecting on my past experiences and will be applicable to my future career. The intensity of competition will likely fluctuate as I move forward in my professional trajectory. Though this application of my analysis of Starzl's approach to colleague-competitors was focused on student experience, his approach may be fruitfully employed by colleagues in any competitive space. The analytic framework and vocabulary I developed may serve as the foundation for future research on collegial relationships and team-building in other competitive spaces.

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