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FROM TEST TUBE TO TEAMWORK: THE ELEMENTS OF TEAMWORK THAT ARE MOST IMPORTANT IN BIOTECHNOLOGY JOBS

A Dissertation Submitted in Partial Fulfillment of the
Requirements for the Degree
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ABSTRACT

From Test Tube to Teamwork: The Elements of Teamwork That Are Most Important in Biotechnology Jobs

By Robin N. Farmer, EdD

Purpose. The first purpose of this study was to describe the perceptions of nonmanagerial cross-functional project team members working in the research and development (R&D) sector of biotechnology regarding which of the eight elements of teams' effectiveness are most important for success. The second purpose of the study was to examine the relationship between demographic characteristics of team members and those elements perceived as most important.

Methodology. The subjects of this study were 183 employees who worked in the R&D sector of biotechnology companies in the Southern California region. Subjects participated in an online survey producing quantitative results. The results from the survey were not only responses to questions about team effectiveness; results were also provided from three different demographic standpoints of the participants.

Findings. Survey respondents showed a strong response to the element of communication as being an important overall element needed for team success. In the area of the demographics, females responded more to the element of communication, whereas males responded more to the element of having their ideas being acknowledged. With the demographic of ethnicity, African Americans had a higher level of response to freedom of communication, Caucasians and Hispanics/Latinos had a higher response to overall communication within their teams, and Asians responded highly to wanting to receive feedback from their leaders. Lastly, in the demographic area of years of experience, of those with less than 2 years of experience within the industry, receiving feedback from their leaders was deemed most important. For those with 2 to 5 years of experience, the most important element was feeling that they were gaining personal development within their teams. For those with over 5 years of experience, the highest percentage of responses was to the element of communication within the team.

Conclusions. The data strongly showed that communication is an important element for teams to possess within this industry in order for them to be successful.

Recommendations. The research literature supports the findings that pertinent communication is lacking among teams in the biotechnology industry. Companies would greatly benefit from putting processes in place that would ensure that constant communication is consistently flowing within project teams.

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DEDICATION

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CHAPTER I

INTRODUCTION

> Coming together is a beginning, keeping together is progress, working together is success.
>
> —Henry Ford

When an individual has an ache or a pain and reaches for medication to help cure that ailment, he or she rarely thinks of the complex development process or the intensive teamwork that went into bringing that medication from the lab, through drug approval, to the pharmacy, to the consumer. Indeed, biotechnology drug development is a highly regulated, lengthy, and complex endeavor taking place against a tough competitive and equally regulated environment (Knowles, 1995). Although most teams in this industry are extremely skilled technically and scientifically, only a well-functioning team can navigate an environment that has compressed deadlines and unforeseen changes to the extent the environment in the biotechnology industry entails (Föller, 2002).

People working in team environments create the medicines that biotechnology companies make, similar to the creation of many products. These teams must be successful to develop the products and obtain the approvals necessary to make the products available to consumers. When team members work together in a productive and innovative manner, they have the potential to empower the organization in which they

operate (York, McCarthy, & Darnold, 2009). Team members experience a great sense of accomplishment when they manage to work together successfully. Senge (1998) asserted, "For many, their experiences as part of truly great teams stand out as singular periods of life lived to the fullest" (p. 13). However, maintaining effective teams can be challenging. In most cases, the team leader organizes and assigns team members in accordance with the task at hand. This approach may also lead to team dysfunction, especially when team members do not agree on how work should be done. Nevertheless, the rewards gained from well-functioning teams make putting time into knowing what makes a team successful a worthwhile challenge for most organizations (Schilpzand & Martins, 2010).

The nature of biotechnology is one of constant change and innovation. This growing field is approximately three decades old and is under constant change and regulation (Zeller, 2002). Known for its utilization of the team structure, biotechnology involves fundamental breakthroughs in understanding genetic processes (Duroy, 2011). Scientists and business leaders widely perceive biotechnology to be the next great frontier of scientific advancement (Joos, 2003). Although this industry is thriving and possesses the ability to improve the lives of those who are ill with the drugs it produces, its long-term success depends on a strong understanding of and support for its employees, who are part of the industry's intellectual property (Casper & Whitley, 2000). Success depends on hiring and retaining the best available clinical scientists and administrative staff familiar with regulatory knowledge. Scientists are responsible for identifying and researching new indications of diseases, while clinical administrative staffs with

specialized training and knowledge move unapproved drugs through the U.S. Food and Drug Administration (FDA) regulation approval process. Both types of knowledge are an important part of the industry's intellectual capacity and property; without them, the companies would not succeed (International Medical Advisory Panel [IMAP], 2011). Retaining intellectual capital through development of a strong culture based on collaboration and teamwork is imperative for biotechnology companies.

Background

Biotechnology companies produce medications and devices that have the ability to cure, manage, and protect people from illness. With such powerful potential, individuals who work outside of the biotechnology industry could perceive biotechnology organizations as well-organized environments (Duroy, 2011). However, the functionality of team performance is an area sparsely studied in biotechnology (Pisano, 2006a). Team-based work is, for the most part, flourishing in today's organizations. Without some level of research on this subject, however, how teams can function to their highest potential in this industry will remain unknown.

The degree and type of diversity found within teams play a major role in team members' performance and satisfaction (York et al., 2009). York et al. (2009) explained that teamwork is a necessary element of the process of developing a product from the bioscience industry due to the "complex set of cross-disciplinary knowledge, skills and talents" involved (p. 138). Furthermore, York et al. stated that "such teams often fail to fulfill their potential and are sometimes quite dysfunctional" (p. 140). According to

Pentland (2012), some type of team support is used to accomplish company goals in approximately 48% of biotechnology companies. Unless the team members have compatibility, they will not be effective (Pentland, 2012). Pisano (2006a) further explained potential problems plaguing teams within the biotechnology industry due to the interplay of tension between science and business. Pisano explained that understanding how teams work in the biotechnology industry is akin to understanding a geographic location and the species that lives in it. Polar bears need fur to survive in the Arctic, but in a desert environment, a bear would not thrive. What works for businesses in nonscientific industries does not necessarily work in science-based industries (Pisano, 2006a). Not understanding the difference can lead to dysfunction. Dysfunctional teams in the biotechnology industry may not lead to the approvals needed to bring drugs to market (Pisano, 2006b).

Team dysfunctions can arise for different reasons. Biotechnology firms suffer from the same organizational struggles as any company, due to the internal factors of the business environment (Lindgren & Packendorff, 2011; Westley et al., 2011). Teams operating within the biotechnology industry generally include a collection of individuals who are independent in terms of their tasks but must share responsibility for collective outcomes and thus need to see themselves as part of a social entity (York et al., 2009). Team members must not only be concerned with their primary task, but they must also be aware of other related tasks and focus on how to accomplish larger group goals. Unfortunately, team leaders, such as managers, rarely understand what is required to keep a team of people motivated and effective (Pentland, 2012). Many managers have focused

on inspiring group spirit and a sense of collaboration to increase effectiveness. However, Harvey and Drolet (2004) explained that developing a group spirit "is not team-building; this is simply a sugar high that evaporates in the system as quickly as it comes" (p. 13). Although team spirit is important, building an effective team involves much more than team spirit in any environment, including primarily knowing what the team members deem important to team success and putting the concepts into practice. Only the team itself can answer the questions of what can make them successful (Bossche, Gijselaers, Segers, Woltjer, & Kirschner, 2011).

According to the analytical market information on the subject of science-based industries, the biotechnology industry and the development process of the drugs it produces face challenges due to several market factors (IMAP, 2011). The challenged areas that have been most recently identified as the top five major factors contributing to the current stagnating environment in the biotechnology industry are (a) expiration of patents on current drugs, (b) uncertainty of drug safety with tougher FDA standards, (c) pressure to keep costs low on drugs that are more expensive, (d) generics market, and (e) increasing competition for the same indications (Datamonitor, 2011a; Druskat, Mangino, & Flynn, 2007; IMAP, 2011; Lindgren & Packendorff, 2011; Sartori, Steinmann, Evers, & Jantzer, 2011). These market factors affect entire organizations, presenting complex situations in which individual companies must overcome the barriers to bring their drugs to the market quickly. Creating effective teams, so that companies can remove barriers to bring their drugs to the market, can be challenging but is necessary when working in a heavily regulated environment. Developing effective teams is

imperative for biotechnology companies to be successful in product development and drug approval (Kearney, Gebert, & Voelpel, 2009; Robbins & Finley, 2000).

Research focusing on what makes a successful team indicates that eight key elements are necessary to achieve success. These elements include (a) having a clear purpose, (b) ensuring clear performance goals, (c) allowing members to express their ideas freely, (d) acknowledging differences, (e) allowing questions and listening, (f) forming the team organically, (g) providing feedback, and (h) providing challenging tasks or goals for team development (Bass & Bass, 2008; Bolman & Deal, 2008; Chi, Chung, & Tsai, 2011; Goleman, Boyatzis, & McKee, 2002; Hackman & Wageman, 2005; Harvey & Drolet, 2004; C. McGregor, 2004; Pentland, 2012; Robbins & Finley, 2000; Shonk, 1992; Wageman, 2001; York et al., 2009).

The first element, having a clear purpose, has been an important attribute for effective teamwork (Bossche et al., 2011). Harvey and Drolet (2004) asserted that "groups without jobs to do together might be congenial, fun, or dynamic, but they cannot form teams because nothing necessitates their long-term cooperation" (p. 16). Team members must understand the purpose of their team to work effectively.

Second, although the team members should understand the purpose of the job they are performing, they should also have a clear understanding about performance goals, including expectations and timelines (York et al., 2009). Bolman and Deal (2008) asserted that "if a team fails to establish specific performance goals or if those goals do not relate directly to the team's overall purpose, team members become confused, pull

apart, and revert to mediocre performance" (p. 111). Clearly, understanding specific goals is a necessary aspect of any team.

Once the purpose and goals are clear and established among team members, communication is the third important element for a successful team (Shonk, 1992). With teams being a collection of people, differences tend to exist among individuals in personality, opinions, and working styles (Chi et al., 2011). Shonk (1992) suggested that communication, combined with mutual support and respect, would render these differences easier to deal with. As far back as 1960, communication was considered an important part of teamwork. D. McGregor (1960) asserted that people should be able to express their feelings and voice their ideas in a team setting. If every idea is heard, the dynamics of the group may be stronger. Therefore, fourth on the list of team elements is the acknowledgement of differences among the team members. By acknowledging differences, members of the team can feel validated and can more readily accept others' views if they know that other members hear their own views as well (Chi et al., 2011).

Bolman and Deal (2008) spoke to the fifth element of team success by stating the importance of allowing questions and listening. Bolman and Deal stated that questions are effective in preventing lapses in communication and stagnation of work. Whether a team is discussing a task to be completed or embarking on a new project, asking questions is key to making sure that all other aspects of the team work well. Harvey and Drolet (2004) stated that allowing group members to speak their minds can help avoid the development of "rumor, innuendo, enmity, greed, and spite" (p. 30), which can become the downfall of even the best teams. Leaders of teams should not be the only ones asking

questions of the team. Members within the team should be questioning each other when certain aspects need to be addressed. If a team member asks a question, listening must be on the reciprocating end (Bass, 1985). Much like the fourth element of acknowledgement, listening must be part of the question process for the individual to feel validated.

The sixth element of team success relates to teams that can organically form in a natural, unstructured environment, when appropriate. Teams that have members who can communicate in an organic, nonstructured fashion have the potential to eliminate barriers that contribute to ineffective teamwork (Hackman & Wageman, 2005). Feedback, the seventh element of effective teams, is essential when working on a specific project goal and helps to ensure that team members accomplish the right tasks. Robbins and Finley (2000) stated that effective teams "develop a method for providing continuous feedback," which prevents the process from becoming stagnant (p. 19). This feedback is acquired not only through formal channels but also via informal methods to ensure "more frequent, real-time, relevant feedback on people, processes, team support structures, and outcomes" (Robbins & Finley, 2000, p. 128). Although similar to communication, the provision of feedback differs in some important ways. Feedback can enrich communication by providing specific information on a specific task to either the individual or the team as a whole. William Dyer (1994) stated the importance of feedback by asserting that "people need to be recognized for the work that they do" (p. 165). This element of giving feedback as recognition of understanding an issue helps to set the basis for team success.

The eighth and final element of effective teams is the inclusion of challenging tasks and goals within the organization. Wageman (2001) suggested that the team be provided an objective "that requires performance that exceeds previous levels," based on an objective measure of performance (p. 120). Setting parameters around projects that include performance benchmarks can increase the sense of accomplishment among members of a team, while at the same time facilitating the measurement of their results.

Although these eight elements do not compose an exhaustive list of contributors to team effectiveness, they do provide a summary of the most common attributes put forth by influential researchers throughout the last 50 years. These eight elements are recurring constants throughout the literature that lay a basic groundwork for the success of teams in any environment where teams are present. Successful teams are teams that use these elements. However, no information in the literature exists on the degree to which these elements are utilized in the biotechnology industry.

Statement of the Problem

Medicines produced by biotechnology companies have the potential to improve greatly the health and longevity of many people. Company leaders are constantly racing to develop new drugs and processes to cure some diseases and help to prevent others. For biotechnology companies to be successful in this race, they require the combined talents of scientists and nonscientific staff working in teams. Both executives and employees understand that team behaviors, practices, and external situational factors can differentiate the highest performing cross-functional pharmaceutical teams from teams

that are not as effective, and they know that this is imperative (Druskat et al., 2007; Pisano, 2006a).

Because of the science-based nature of biotechnology, employees in this field need a different skill set than do employees in other non-science-based business settings (Pisano, 2006b). For an industry in which success depends on continual innovation and teamwork, having a deep understanding of how successful teams operate is crucial. In most cases, employees hired to work in biotechnology are suited to do so because of expertise in science, knowledge of regulations, and other requirements pertinent to the job (Larbey, 2002). For this reason, teamwork is even more important than in other industries to integrate the differing skill sets needed for the job and those needed for the success of these diverse teams (Datamonitor, 2011b). Unfortunately, these aspects of team effectiveness in this industry tend to be understudied.

In a study of drug development teams in biotechnology companies, Druskat et al. (2007) described the challenges with establishing effective teams as follows:

> Leaders in this business are cognizant of the benefits of higher performing teams, and are regularly looking for improvement opportunities. However, this is only in principle that they are interested in becoming more productive. The scientists, physicians, strategic marketers, and engineers who are key members on these teams are frequently skeptical of team performance models and tools that do not seem to fit their work context, with little discretionary time to devote to reflection on their "process," and with little interest in suggestions that were not practical and relevant to their business context. (p. 45)

Pisano (2006b) added to this by stating that there is a lack of time spent on building well-functioning teams in the biotechnology industry:

> Drilling for oil or making a Hollywood movie is risky. Most oil wells run dry and most Hollywood films do poorly at the box office. But discovering an oil well is

> dry or that a film is a dud takes a relatively short period of time. In science however, the uncertainty and risk may linger for years, sometimes decades. Cancer continues to prove to be a devilishly difficult disease to understand and treat despite several decades of massive investments in basic research. And even if a solution can be found, one needs to have a strong R&D [research and development] team invested to this process. Yet with all the time taken to invest in the implications, we do not take time to invest in the teams who work to develop medications in this research. Why? (pp. 8-9)

Föller (2002) stated,

> Despite over 50 years of research on teamwork there is no single unifying theory that integrates the diverse literature on the subject on biotechnology . . . moreover, none of the tools and models that are examined focus on teamwork and collaboration in pharmaceutical settings. (p. 179)

Like other industries, biotechnology companies have been facing the challenges of budget cuts and lower sales. Additionally, they have faced fierce competition from other biotechnology companies, as well as regulations that have increased the difficulty in getting important drugs to the market (MacDonald, 2004; Wechsler, 2011). Unlike other industries, the business of drug development is a costly and highly regulated environment that leads to the pressures of accomplishing the job quickly yet efficiently. Introducing a new drug to the market, from the point of being discovered to going through the clinical trials and finally getting approval, involves a complex and costly process. What sets the biotechnology industry apart from other businesses is that in most cases, biotechnology companies do not receive a profit until the drug is approved by the FDA and is subsequently put on the market. However, the costs of research and development are being expended during the development phases with no guarantee of the drug's approval (Fildes, 1990). This circumstance speaks to the regulated environment of

the business. The FDA plays a paramount role through many of the phases of the drug development stage, not just during approval.

Good clinical practices, which are guidelines that must be followed to protect human rights in clinical trials, should be at the forefront of all work being conducted in biotechnology research and development (Joos, 2003; Light, Castellblanch, Arredondo, & Socolar, 2003). Ultimately, the employees working in this industry, particularly in the research and development (R&D) areas of the company, work for the patients in need. That focus can make working in this industry different from working in other industries. Though teams cannot address all of the issues that the industry faces, employees' working effectively and being aware of all regulations that pertain to their environments are key to success.

The biotechnology industry would benefit significantly by conducting more research on team elements to increase understanding about internal teams and the elements needed for them to be successful (Fildes, 1990; IMAP, 2011; Khilji, Mroczkowski, & Bernstein, 2006).

Purpose of the Study

The first purpose of this study was to describe the perceptions of nonmanagerial cross-functional project team members working in the R&D sector of biotechnology regarding which of the eight elements of teams' effectiveness are most important for success. The second purpose of the study was to examine the relationship between

demographic characteristics of team members and those elements perceived as most important.

Research Questions

The following research questions were developed for this study:

1. To what degree do nonmanagerial cross-functional project team members working in biotechnology perceive that the eight elements of teams are important for success?
2. What do nonmanagerial cross-functional project team members working in biotechnology perceive as the single most important element of the eight elements of teams that are most important for success?
3. Is there a significant difference in perceived importance of team elements based on gender?
4. Is there a significant difference in perceived importance of team elements based on ethnicity?
5. Is there a significant difference in perceived importance of team elements based on years of experience in the biotechnology industry?

Significance of the Study

The drug discovery and development process requires close working relationships of individuals from a large number of different departments for as long as 5 to 8 years. Most biotechnology firms have teams that work through the processes of drug development with the goal of bringing the drug successfully to the market. Teams involved in the various processes have many responsibilities, which may include

functions such as researching the particular indication for the compound that is being studied, preparing drug development plans, designing the research, implementing the research with doctors and patients, monitoring the status of that research, comparing the research results, and presenting those results to the authorities for approval (Lakings, 2001). These steps in developing drugs are necessary for drug approval. This process cannot be completed by one individual but can only be accomplished when teams work together. The field of biotechnology plays a major role in the science-based business world today, and it thrives not only on internal teamwork but also on overall innovation (Gobble, 2011). The process of companies continuing to invent products to stay ahead of the competition is important now more than ever. Current literature on drug development states, "In today's market, differentiation [with products] is more important than ever. Big Pharma's customers increasingly are payers [buyers of the drugs] (very often government units) and patients who care about two criteria: health outcomes and affordability" (IMAP, 2011, p. 8). All biotechnology companies need innovation and growth, due to the constant changes and improvements of products and regulations (Sartori et al., 2011). This growth can only occur when the basic units of the companies and their teams are all fully functional.

Teams in this industry are constructed strategically based on skill. However, without an understanding of the necessary team elements, even the best teams may have little hope of survival (Abbott, Boyd, & Miles, 2006; Cukier, 2006; Mulec & Roth, 2005). Teams that are not well suited to handle day-to-day routine tasks may have even

greater issues handling aversive external factors, which may further inhibit company overall success (Pisano, 2006a). Druskat et al. (2007) stated,

> Less effective teams struggle and become stuck in a loop of conflict, rework, and firing fighting. This unproductive behavior results in lost time (a particularly precious commodity in this environment), decreased levels of engagement and, ultimately, lost resources and business opportunities. (p. 25)

Loss of time and ineffective teamwork can be detrimental in any business, but in an industry in which the well-being of others is at stake, working as efficiently as possible is a benefit to all.

Individually, the eight team elements chosen for this study are commonly known to be important factors to success in a team environment. When working in biotechnology companies, particularly on the R&D side, the idea that employees must wear many hats to complete a task successfully is stated often (Larbey, 2002). Though team members may understand this concept, executing this process in the team environment takes skill. Working cross-functionally in biotechnology companies is a given. Teams can be composed of individuals with different skill sets, years of service in the industry, and socioeconomic backgrounds. Therefore, choosing a comprehensive mix of important elements will more likely ensure team success in biotechnology (Burtscher, Kolbe, Wacker, & Manser, 2011; Dimotakis, Davison, & Hollenbeck, 2012).

The significance of the current study is that it may start to fill the gap in literature and add to the body of knowledge regarding the elements of teams that contribute to success.

Definitions

Big pharma. A term that encompasses the largest players in the pharmaceutical industry (IMAP, 2011). In this study, the terms *biotechnology* and *biotech* are used in lieu of and interchangeably with the term *big pharma*. Big pharma represents the larger biotechnology companies, which have more complex organizations than do other biotechnology companies. However, at the core of big pharma companies is the biotech industry; therefore, for the purposes of this study, they are the same and are used interchangeably.

Biotechnology industry. An industry that provides products and processes for the diagnosis, treatment, and cure of human disease, as well as the development of genetically customized animals, plants, and food (Aggarwal, Gupta, & Bagchi-Sen, 2001).

Cross-functional team. A group of people with different functional expertise working toward a common goal (Kruyt, Malan, & Tuffield, 2011).

Good clinical practices. An international quality standard provided by the International Conference on Harmonization, an international body that defines standards, which governments can translate into regulations for clinical trials involving human subjects (MacDonald, 2004).

Intellectual property. Property that derives from the work of the mind or intellect, has commercial value, and includes any intangible asset that consists of human knowledge and ideas. Examples include an idea, invention, trade secret, process,

program, data, formula, patent, copyright, trademark, software or application, right, registration, business method, or industrial process (Gobble, 2011).

Mental models. Deeply ingrained assumptions, generalizations, or even pictures or images that influence how individuals understand the world and how they take action (Senge & Scharmer, 2006).

Organic team. A team organized according to a common product, customer, or service (Michael, 2012).

Project team. A team whose members usually belong to different groups, but can be from the same group, and share functions and activities assigned for the same projects (Chi et al., 2011).

Regulatory. Pertaining to working within regulations, companies that comply with all of the regulations and laws pertaining to their business. Pertaining to working with federal, state, and local regulatory agencies and personnel on specific issues affecting a business (Föller, 2002).

Research and development (R&D). Departments and actions geared toward discovering new knowledge about products, processes, and services, and then applying that knowledge to create new and improved products, processes, and services that fill market needs (Thorsteinsdóttir, Ray, Kapoor, & Daar, 2011).

Science-based business. A business that uses scientific knowledge to create innovative products and solutions (Bell, Willson, Wilman, Dave, & Silverstone, 2006).

Self-organization. A system of cooperative elements for which the patterns of global behavior are distributed (i.e., no single element coordinates the activity) and self-limiting (Wheatley & Kellner-Rogers, 1996).

Shared mental models. Shared representations of tasks, equipment, working relationships, and situations (Bossche et al., 2011).

Silo. An information management system that is unable to communicate freely with other information management systems. Communication within an information silo is always vertical, making it difficult or impossible for the system to work with unrelated systems (Chi et al., 2011).

Team. A collection of individuals who are interdependent in terms of their tasks, share responsibility for collective outcomes, and see themselves and are seen by others as a social entity (York et al., 2009).

Team elements. This term refers to eight elements: (a) clear purpose, (b) clear performance goals, (c) freedom to communicate and express ideas, (d) acknowledgement of differences, (e) the asking of questions and listening, (f) organic formation of team, (g) provided feedback, and (h) challenging task goals that provide the team development (Bass & Bass, 2008; Bolman & Deal, 2008; Goleman et al., 2002; Hackman & Wageman, 2005; Harvey & Drolet, 2004; C. McGregor, 2004; Pentland, 2012; Robbins & Finley, 2000; Shonk, 1992; Wageman, 2001; York et al., 2009).

Transformational change. Change that is major in scope and discontinuous with the past (Weick & Quinn, 1996).

Delimitations

This study is delimited to biotechnology companies in Southern California and the cross-functional nonmanagerial project teams working in the nonscientific R&D departmental area of the industry.

Organization of the Study

This study is organized into five chapters. Chapter I provided the background and purpose of the study. Chapter II includes the pertinent literature and research for the study. Chapter III contains the methods and design used for the study. Chapter IV includes the findings of the study. Chapter V provides an overview of the problem, analysis, major findings, the conclusion, and recommendations for future research.

CHAPTER II

LITERATURE REVIEW

Biotechnology has the potential to bring tremendous benefits.

—John Prescott

Biotechnology as an industry has a rich history spanning many years, with complexities concerning how it came to be the blockbuster business in the scientific sector that it is today. Working on the administrative business side in the biotechnology field is a unique experience that can differ from working in a nonscientific business industry, as the foci on the development of the drug and the patients are different from the foci of business in other fields (Pisano, 2006a). Though traditional hierarchical team-based structures exist in some biotechnology businesses, the structure of the industry is such that distinctive differences in the operation of teams may occur. Science-based industries thrive due to the sharing of information on the science side of the operations (Patzelt, zu Knyphausen-Aufse, & Nikol, 2008). Science's roots are in methodologies and repetitive practices. However, biotechnology companies do not operate on the science alone; administrative expertise is necessary to function as well. Though the science side of the administration is methodical, the business side can be fluid and results oriented (Gobble, 2011). Though both sides can have individuals working in team-structured environments, the way in which the teams function may vary. The sole

difference between science-based businesses and corporate-based businesses is that biotechnology has to thrive as a business with the duality of both sides of this competing spectrum (Khilji et al., 2006). Though all businesses experience transformational change at some point, biotechnology, as a business, is an ever-changing environment, constantly innovating and reinventing itself to keep up with the demands of the patients it serves, as well as the medical advances and trends of the time (Duroy, 2011; Fildes, 1990). With an innovative and changing atmosphere, coupled with the dual surroundings of science and business, the team structures established need to be designed to foster success if they are to shape the working environment of the biotechnology industry further.

This literature review presents an overview of the history and development of the biotechnology industry, internal operational factors (i.e., profit needs and lifecycle of drug approval), and external operational factors (i.e., conceptual framework of the industry and business competition aspects) of biotechnology as an industry. The review includes an exploration of the history of organizations and their structure, focusing on research and development (R&D) to give a complete view of the history of biotechnology organizations. Also included is a presentation of the literature on teams and team effectiveness to provide a foundation for teams and identification of core elements of teams as well as barriers. Chapter II concludes with an exploration of team structures.

Biotechnology History and Development

The history of biotechnology dates back as far as 4000 BCE, when yeast fermentation was used to produce ethanol for consumption. The first known application

or medical use of biotechnology was in 500 BCE, when soy mold was used in China to treat boils (Johnson, 2008). In 1590, the microscope was invented. In the early 1800s, proteins were discovered. By the mid-1800s, Charles Darwin published his theory of evolution, thus starting the discussion of genetics. Gregor Mendel, whose experiments involved garden peas and their genetic traits, continued this discussion shortly thereafter. Not until the early 1900s did the discovery of bacteria, viruses, and diseases in a biological format occur. This discovery led to biotechnology's first mention in print in 1919. By the mid-1900s, deoxyribonucleic acid (DNA), molecular disease, and enzymes were all becoming common fixtures in the biotechnology world (Johnson, 2008). The subsequent publishing of James Watson and Francis Cricks's manuscript on the structure of DNA marked the beginning of the era of genetics (Chataway, Tait, & Wield, 2006). Equally important in biotechnology history as Watson and Cricks's research was the development of penicillin. Not only did penicillin reconnect pharmaceuticals of the day with chemistry, but it also helped to validate biotechnology as an industry. Penicillin was a lifesaving drug that needed to be manufactured, and it was ultimately sold to millions. This property of penicillin broadened the public's perception of drugs sold by companies (Chataway et al., 2006; Larbey, 2002).

Biotechnology in the commercial industry has benefited from the advances of technology and research. Scientists, biologists, chemists, and other pioneers worked with and researched proteins, bacteria, enzymes, and hormones, leading the way to creating the field of biotechnology. Due to this rigorous form of technology and research, small biotechnology firms came on the scene in the late 1970s (Wang et al., 2003). By the mid-

1980s, biotechnology firms worked as science-based businesses (businesses focused on science) and genetically engineered products that required approval by the U.S. Food and Drug Administration (FDA; Wang et al., 2003). Biotechnology as an organization today is defined by the FDA (2013) as follows:

> Techniques used by scientists to modify deoxyribonucleic acid (DNA) or the genetic material of a microorganism, plant, or animal in order to achieve a desired trait. In the case of foods, genetically engineered plant foods are produced from crops whose genetic makeup has been altered through a process called recombinant DNA, or gene splicing, to give the plant desired traits. Genetically engineered foods are also known as biotech, bioengineered, and genetically modified, although "genetically modified" can also refer to foods from plants altered through methods such as conventional breeding. (para. 2)

The biotechnology industry is based on finding new scientific discoveries that can directly aid the needs of the market it serves. The biotechnology industry is not restricted to products and services that need to be manufactured for a customer. Research and innovation to produce products is the formula that has been used in both the past and present in science-based industries as a way to work toward success. Today, both individuals working in the industry and those who can benefit from the products biotechnology companies market view biotechnology as revolutionizing healthcare and improving the process of drug research and development (Bell et al., 2006). Ramos-Rodríguez and Ruíz-Navarro (2004) spoke about biotechnology as a scientific industry:

> The ability to manipulate the genetic codes of living things will set off an unprecedented industrial convergence; farmers, doctors, drug-makers, chemical processors, computer and communications companies, energy companies, and many other commercial enterprises will be drawn into . . . what promises to be the largest industry in the world. (pp. 990-991)

The term "big pharma" is used to reference major pharmaceutical companies (large as opposed to smaller companies) in the world (IMAP, 2011). These companies are known for turning research into drugs that can involve both traditional and nontraditional methods, and for charging top dollar for the drugs that they do produce. These larger companies can also have the means to discover new indications for disease in the market and develop from scratch antidotes through molecules for those indications (Gretton, 2009; Johnson, 2008). Big pharma has on occasion carried a negative connotation because these companies are at times scrutinized for their use of nonnatural methods of prevention and for inflating the price of their drugs. On the other hand, big pharmaceutical companies also have been responsible for blockbuster drugs and the accompanying sales (Pisano, 2006b). This distinction between big pharma and smaller pharmaceutical companies is used as a definition in news articles, as well as by the federal government when classifying companies. Quality, safety, and efficacy are also terms that can be used when discussing big pharma for continued efficiency in their business as well. Journalist Linda Gretton (2009) spoke to the illusion of large pharmaceutical companies:

> Biotech relies on messages of process and potential since many of its projects have not yet transitioned from theory to actuality. The most powerful and transformative biotechnology industry attributes are captured in the words *promise* and *potential*. As future-focused words, they abet a malleable and personalized vision of how science could, should, and ought to be. (p. 240)

Internal and External Factors of the Biotechnology Industry

A way for a biotechnology company to gauge its progression as a company is by its appeal to buyers in the markets. Bringing drugs to market is no quick feat in the biotechnology world (Khilji et al., 2006). The process happens in stages, as shown in Figure 1. It is a long process, usually taking around 8 to 10 years of research, clinical trials, and passing government FDA regulations before the drug is available for public consumption. The process is also extremely expensive for the company, costing anywhere from thousands to the multimillion-dollar range during that period (Fildes, 1990).

A critical stage in the drug development process is the R&D function. R&D encompasses a host of different critical departments in the biotechnology industry (Collins, 2011). Teams working within this function play a pivotal role in moving the drug at an early stage through the drug development process, having strong knowledge of the regulations required for different stages in the process (Khilji et al., 2006). Scientists working with the molecules that eventually may become marketed drugs also participate in R&D. However, this R&D differs from R&D that takes place on the nonscientific side of the industry (Fangzhu, Cooke, & Fulong, 2011). R&D on the nonscientific side is the process of discovering the newest products and developing them to the point of getting them on the market. The process of discovery and development is one that keeps the biotechnology industry functioning; without it, no information would be in the pipeline of the company from which to develop products (Collins, 2011). R&D employees in the

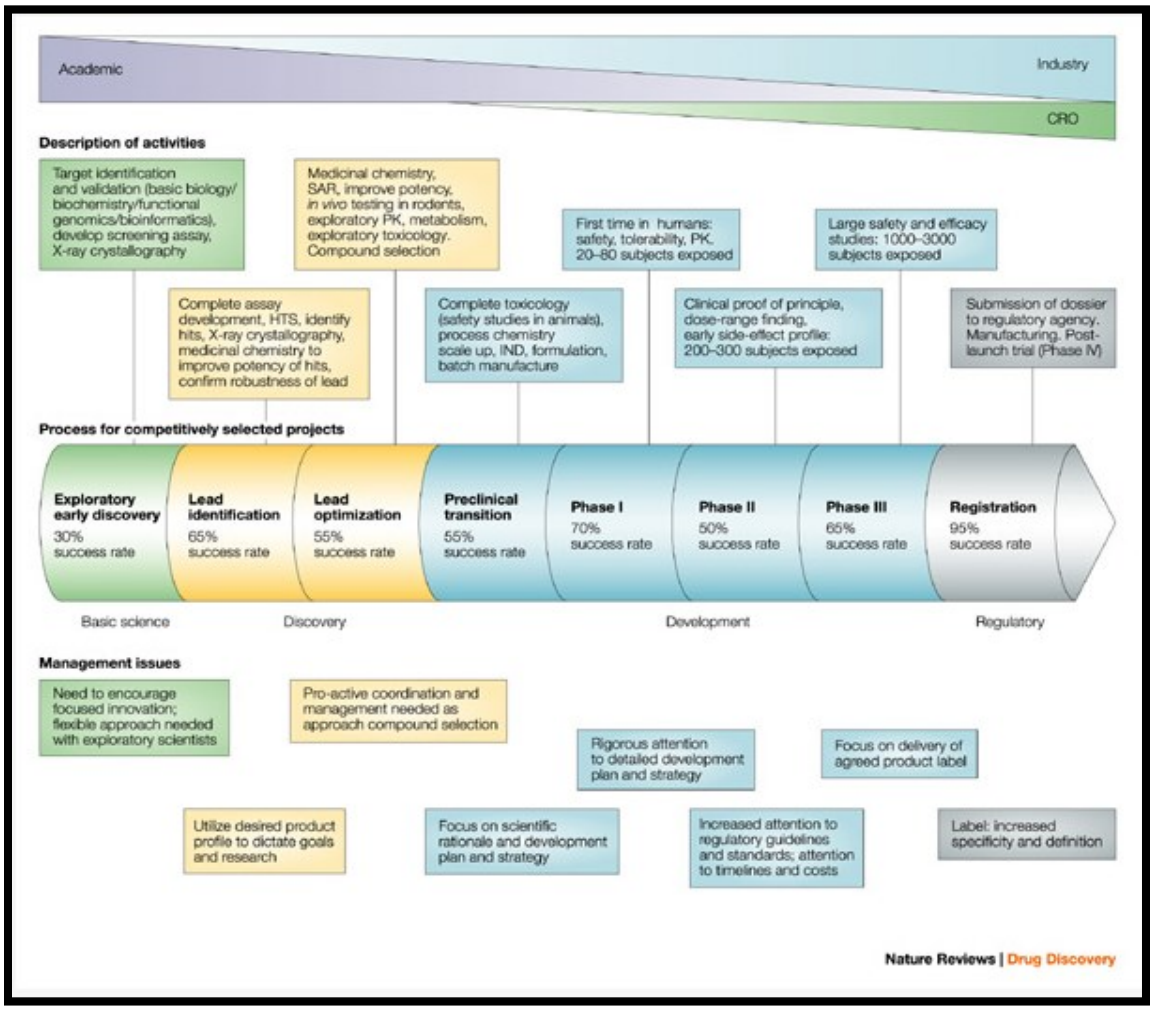

Figure 1. The pharmaceutical product development value chain. From "Drug Repositioning: Identifying and Developing New Uses for Existing Drugs," by T. T. Ashburn and K. B. Thor, 2004, *Nature Reviews Drug Discovery, 3*, p. 673. Copyright 2004 by Macmillan. Reprinted with permission.

industry of biotechnology are considered to have specialized sets of knowledge for that particular sector of the company and, in most cases, are allotted budgets specific for their function. Table 1 displays how biotechnology companies worldwide allocate money spent and revenues for the R&D areas of companies (Dimotakis et al., 2012). Individuals working in this area of the company have knowledge of the processes needed to perform

their functions, and they take all steps necessary to get the drug developed per regulatory and good clinical practices standards.

Table 1

Key Indicators of Biotechnology Companies Around the World, 2012

Country	Companies	Employees	R&D employees	R&D spend (US$, billions)	Revenue (US$, billions)
China	About 500	50,000	30,000	1.80	2.40
United States	1,991	190,462	79,344	28.36	56.18
United Kingdom	457	21,134	9,384	2.11	6.12
Germany	538	16,094	8,132	2.04	3.94
France	223	9,142	4,246	0.80	2.97
Sweden	138	3,942	2,579	0.50	1.16

The 2011 Datamonitor *Industry Profile: Global Pharmaceuticals, Biotechnology & Life Sciences*, which addressed all aspects of the biotechnology and life sciences industry, indicated that two of the lowest levels of buyer power for biotechnology companies were backwards integration (i.e., a consumer acquiring his or her supplier and setting up his or her own facilities to better manage the cost of an undifferentiated product) and product dispensability, as can be seen in Figure 2 (Datamonitor, 2011b). These factors are essential to a biotechnology company and to its overall viability as a company in the marketplace. More important than how these areas have an effect on the business is what is being done on the inside of the company at the employee level to combat these types of weaker areas of the industry (Khilji et al., 2006; Westley et al., 2011).

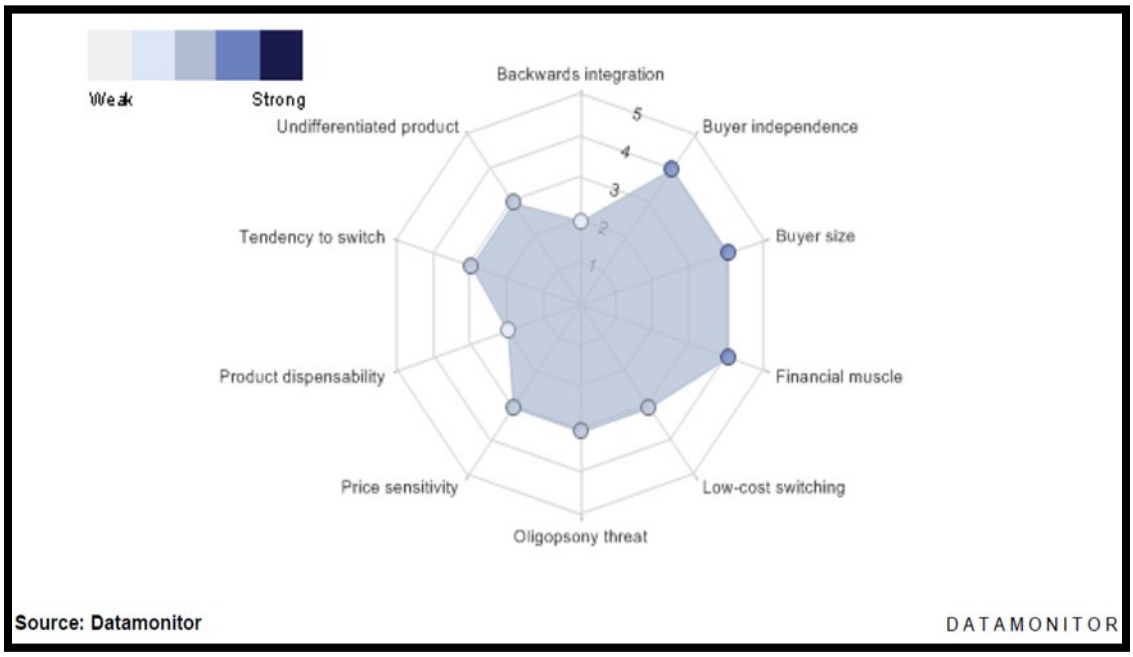

Figure 2. Drivers of buyer power in the global pharmaceuticals, biotechnology & life sciences industry, 2010. From *Industry Profile: Global Pharmaceuticals, Biotechnology & Life Sciences*, by Datamonitor, 2011b, p. 16. Copyright 2011 by Datamonitor. Reprinted with permission.

Biotechnology companies experience internal strategic challenges stemming from the competitive nature of the business. From a management standpoint, leading others in this work environment can be challenging due to the constant external pressures the company faces to get approval for drugs in the pipeline. Duroy (2011) noted, "The corporate culture of a top-tier biotechnology company is as unique today as it was a decade ago. The challenge for the manager is nurturing this potent yet fragile environment during a period of rapid change and growth" (p. 561). Pisano (2006b) suggested that the biotechnology industry had been structured in such a way that it prevented organizations from thriving in what they do.

The sector has indiscriminately borrowed business models, organizational strategies, and approaches from other high-technology industries under the (false) premise that if the approaches worked for other high-technology fields, they would work for biotechnology. According to Pisano (2006b), "In the very broadest terms, everyone expected biotech to 'work' just like all other high-technology industries, and thus we deployed a lot of the same thinking, models, financial arrangements, and strategies that worked elsewhere, but just didn't fit here" (p. 16).

Tutton and Prainsack (2011) echoed Pisano's (2006b) train of thought by speaking to the expectations of the future of the biotechnology firm: "Firms advance much more pessimistic images of futures that they wish to avoid: possible failures, disappointments and financial losses" (p. 1085). The state of biotechnology is being affected at some level by the business practices currently adopted (Pisano, 2006b). A type of culture that leaders of biotechnology companies have tried to practice regarding talent is only hiring the best and the brightest (Fildes, 1990). This culture is coupled with generous benefits and stock options to allow the employees to invest in the company, consequently feeling more invested in their work (Pisano, 2006b). These tactics have been used by biotechnology companies to help maintain solidarity among the employees. The idea is that failure to satisfy employees could undermine productivity and profitability within the biotechnology industry (Föller, 2002).

Wheatley and Kellner-Rogers (1996) addressed organizational structures in general and the need for organizations to create their own internal identities:

> Organizations lose an enormous organizing advantage when they fail to create a clear and coherent identity. In a chaotic world, organizational identity needs to be the most stable aspect of the endeavor. Structures and programs come and go, but an organization with a coherent center is able to sustain itself through turbulence because of its clarity about who it is. Organizations that are coherent at their core move through the world with more confidence. Such clarity leads to expansionary behaviors; the organization expands to include those they had kept at bay—customers, suppliers, government regulators and many others. (p. 35)

This line of reasoning differs from the documented organizational structural pattern that biotechnology companies utilize in their organizations internally. Pisano (2006b) provided a detailed outline of the conceptual framework of a commonly used internal system framework of the biotechnology business, depicted in Figure 3.

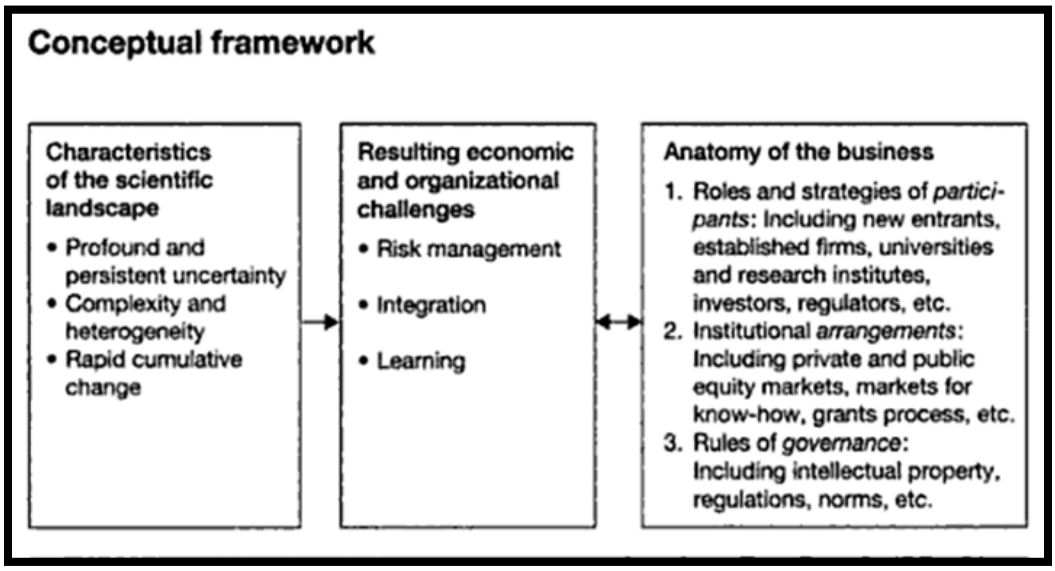

Figure 3. Conceptual framework of a commonly used internal system framework of the biotechnology business. From *Science Business: The Promise, the Reality, and the Future of Biotech*, by G. P. Pisano, 2006b, p. 14. Copyright 2006 by Harvard Business School Press. Reprinted with permission.

Pisano (2006b) furthered his thoughts on his graphic by speaking to the importance of the framework of any business:

> The framing question for the analysis is, if one could design this sector from scratch, what would it be designed to do particularly well? Business sectors cannot be designed. Nor years after the birth of biotechnology, does it make sense to start from scratch. Nevertheless, the question focuses our attention on the notion that all business sectors—biotechnology included—evolve in ways to cope with specific types of economic, technological, and environmental challenges. (p. 12)

The International Medical Advisory Panel's (IMAP, 2011) *Pharmaceuticals & Biotech Industry Global Report* included ideas continuing in the same line of thought as Wheatley and Kellner-Rogers (1996) and Pisano (2006b), with descriptions of the prevailing organizational epic problems of low productivity in the biotech industry:

> As pipelines dry out, many companies have started to experiment with new R&D models. For example, [some companies have] restructured [their] R&D centers to emulate biotech R&D culture. [Companies hope] to replicate an entrepreneurial culture in a large pharma organization. [Other companies have] acquired [other companies] to source innovation from outside the company and then left [the original company] as a stand-alone unit operating independently . . . . Several pharma companies are partnering with leading academic institutions to promote innovation from basic research. The jury is still out on whether these efforts prime the innovation pump enough, however. Broadly, to raise innovation returns back to the level that prevailed in the era of blockbusters, pharma companies need transformational change. Pressing areas of improvement for pharma companies are: increasing managerial autonomy; aligning research goals with incentives; attracting and retaining the right, creative talent; minimizing bureaucracy; and creating flexible organizations. (p. 8)

Lack of identity, use of original conceptual frameworks, and various forms of innovation struggles have affected the internal factors of the biotechnology industry (IMAP, 2011; Pisano, 2006a; Wheatley & Kellner-Rogers, 1996).

Externally as a business, biotechnology is an industry that has much diversity, from the interest the public has in the products that the company makes, to constantly being on the forefront of critical research. Khilji et al. (2006) wrote about some of the strongest points of this industry:

> The distinctive features of this industry are: the strong relationship between innovation and competitiveness, the collaborative basis of research, and the importance of the firm. Biotechnology highlights the importance of firms' capabilities, that is, the ability to mobilize and exploit new knowledge and to reach out and exploit collaboration among the diverse players in the field of scientific disciplines. (p. 55)

However, along with this feature of the industry come the needs to be regulated heavily and to be highly competitive. Regulations and competition are among the two biggest external factors that the biotechnology industry faces (Gretton, 2009). Many smaller companies have competed to develop either similar or, in some cases, the same products (Gretton, 2009). Though possessing the means of high financial resources (such as a big pharma company may have) can be helpful, it does not always lead to generating a product first in the biotechnology world (IMAP, 2011). Moreover, external factors of the business need to be strong so that the company can be a united force against the external issues that can have an effect on the business overall. These external issues include advancements in technologies, constant pressure to innovate, and managing regulations of government agencies, which are oftentimes either unclear or unrealistic for the industry (Thorsteinsdóttir et al., 2011).

Pisano (2006b) evaluated science-based business risk: "Science-based businesses are challenged by the characteristics of science that 'stress' institutional arrangements,

rules, organizational technologies, and management practices" (p. 107). All businesses, from small local coffee shops to large manufacturers, must be prepared to manage risk and uncertainty. However, a science-based industry, like biotechnology, confronts risk and uncertainty far beyond other organizations (Dewhurst, Heywood, & Rieckhoff, 2011). Biotechnology has a history deep in research, with each individual firm at any given time innovating new formulas and systems to aid its research. Other companies, however, may create new products that can rest on the foundation of existing principles and methods used. When biotechnology creates a new product, new rules and regulations may need to be created along with it for consumers to utilize the product (York et al., 2009). This process creates changes and shifts in the organization, which requires a strong foundation. The organizational structure of any business forms the core of how an organization can work through internal and external factors that affect it. The structure of organizations has its own history, and exploring the background will help achieve a deeper understanding of the organizational side of biotechnology.

History of Organizations

Further review of the literature indicated a variety of attempts on the part of various authors over the years to solve the issue of how to organize teams to achieve maximum effectiveness and profitability for an organization. As applied to modern-day corporations, different approaches have historically had limited success at best. Just as people change, consistent with changes in their wants and needs (Wilson, Skehel, & Wiley, 1980), so do organizations. As organizational leaders' priorities change, their

organizations' continued success hinges on continually evaluating and adapting their organizational structures to remain in maximum conformance with their evolving needs and goals. Biotechnology is an industry at its core, and the use of teams in biotechnology organizations has been common practice (Lindgren & Packendorff, 2011).

Organizational structures in the form of teams have been around since the ancient times of tribes, hunters, royalty, and, in more modern times, industrial work. From a military perspective, struggles in this area have existed for thousands of years (Shonk, 1992). The configuration of organizing groups, according to early theorists, was to bring structure, efficiency, and effectiveness to groups of people. In those times, structure was seen as a matter of choice to which people would conform for the good of the order (Mohr, 1982). In the 20th century, theorists started to view organizational structure as a power distribution between management and workers (Mohr, 1982). Attempts to address the topic from a business perspective began with Frederick Taylor in 1917. He advocated adhering to these four steps:

1. Find the "best" (most economical) way to do a job.
2. Match the best worker(s) to it.
3. Supervise them while using rewards and punishments to motivate them.
4. Constantly plan and control the process of producing the product itself. (as cited in Mohr, 1982, p. 75)

This approach worked well for a while (Walonick, 1993). However, modern companies are far more complex in their missions of issues they face within their industry than were companies of the early 1900s. In 1947, Max Weber adapted Taylor's concept to the needs of the postwar era by expanding the hierarchical structure of management (as cited in Dalton, 1959). The idea of specialization was introduced, and thus began the

proliferation of multiple management levels within companies, including the further departmentalizing of organizational structure. In other words, vertical and horizontal integration had begun (Walonick, 1993).

The underlying principle of these and other approaches of the mid-1900s was that theorists looked at management theory from a rigid, mechanical perspective. The humanistic, empathetic view of the problem—seeing workers as people with their own individual quirks and needs, and not as simply pawns on a chessboard—was yet to be explored, let alone practiced. For Taylor and Weber, manipulating workers was the simplistic goal. C. J. Schollenberger and Herbert Simon (1945) did sense the need for a different manner of regarding the workers by advocating *limited rationality*, a rather degrading term that, in a limited way, addressed the growing realization that workers could respond unpredictably to management. Chester Barnard (1968, as cited in Vaughn, 1978) also spoke to the same subject by defining organizations as systems of consciously coordinated activities.

Using a more realistic approach than Schollenberger and Simon (1945) and Barnard (1968, as cited in Vaughn, 1978), Alfred Chandler (1962) viewed conflict between management and workers as inescapable but nevertheless manageable. Followers of Chandler have wrestled with exactly how to manage the conflict most effectively (Walonick, 1993). Joy Lorsch and Paul Lawrence advocated an important step in mitigating worker-management conflict in 1969 (as cited in Kruyt et al., 2011): Push decision-making responsibility down through the ranks to all levels of management. In this way, workers would have a direct influence on their newly empowered immediate

supervisors and thus could positively affect needed changes in how the company operated more easily than they could when upper management made all decisions (Kruyt et al., 2011). Peter Drucker (1974) went further down the road of empowering all management levels by advocating for *federal decentralization*, which involves breaking up a company into separate, independent units, each with its own management structure. The era of the conglomerate and working in teams was born.

With the numbers of groups working together in one organizational structure increasing, Fremont Kast and James Rosenzweig (1972) contributed the concept of the project manager. A project manager is a person running a specific project, with centralized authority for obtaining and disseminating information and directing activities related to that project. This person is not so much a manager as a hands-on technician with direct experience in fabricating or performing the goods or services on which the group is working. Kast and Rosenzweig also disseminated the idea that structural deficiencies in any organization result in low morale and low motivation among the workers.

Biotechnology leaders have grasped onto Kast and Rosenzweig's (1972) idea of project management, but under the modernized term of *project leadership* (Lindgren & Packendorff, 2011). One perspective, for example, is as follows:

> R&D project leadership is a central matter in contemporary organizations in the sense that it plays an important role in bringing new products and services to the market. Through well-functioning R&D project leadership, team formation and team collaboration may be enhanced, project planning and monitoring problems may be alleviated, and the created resolution of advanced technology problems may be stimulated. (Lindgren & Packendorff, 2011, p. 169)

Project leadership in biotechnology takes place at the management level of the company and plays an important role for the company. The guidance provided by the manager can enhance overall function, as Lindgren and Packendorff (2011) suggested. Föller (2002) expanded this idea by adding the dimension that managers in biotechnology companies need different skills from managers in other companies. Föller described three distinct sets of qualities that need to be taken into account for biotechnology managers when hiring:

- General traits that apply to all good managers of all companies in all industries
- Attributes that are particularly important in managers of biotechnology
- Experience that matches the company's particular stage of development. (p. BE64)

Föller (2002), much like Walonick (1993), suggested the idea of distinct steps in a business needed for success among teams that work together. Föller (2002) added the idea that science-based information is vitally important in this industry, and thus well-informed, science-minded management could make a difference in overall company performance.

Teams

Teams in biotechnology are diverse in nature. Individuals with different backgrounds, such as gender, ethnicity, age, years of service in the industry, or level of background knowledge in the field in which the particular biotechnology company specializes (e.g., oncology, medical device, ophthalmology), can make up teams. The strongest members are the ones assigned to a team to accomplish the task at hand

(Mohammed & Nadkarni, 2011). This type of assignment is especially the case when building a team for the development of a drug in biotechnology companies. The team leader wants team members who understand all aspects of brining the drug through the approval stage and to the market (Zeller, 2002). Beyond the need for individuals to function well within teams, biotechnology internal working structures are set up in such a way that teams are forced to work together across different departments to complete day-to-day functions. Therefore, the very nature of the business is a team structure, not only within specific departments but also across the company (Duroy, 2011).

Drug development in biotechnology companies is a regulated function ("Biotech Organization Chart," n.d.). Most drug development processes happen in phases, and each process cannot be completed without the others. The nature of the process requires silos within the organization made up of different teams. Some functions are hierarchically designed, while others are somewhat flattened. Nevertheless, functions within both designs support each other and are equally important for the project completion. The basis of this industry's success is teamwork, so if one function is incomplete, others may fail as well. Yet how teams work toward success in this industry is not widely studied (Cukier, 2006; Pisano, 2006b). Though there are many regulations and different processes within this industry, the broad drug development and the R&D phase are consistently the same across biotechnology companies (Campany, Dubinsky, Druskat, Mangino, & Flynn, 2007; Datamonitor, 2011b). Thus, teams are working in the same manner on the same functions across different companies.

Some of the earliest forms of teams could be seen a hundred thousand years ago with early humans as hunters and gatherers. In those cases, a leader led everyone to do what he or she knew best. The team is a natural unit for small-scale human activity (Robbins & Finley, 2000). Corresponding to the history of organizations and Frederick Taylor's productivity of organizations, during the 1700s and 1800s when the industrial revolution started to take form, mass assembly operations engendered the need for the formation of teams in a business format (Robbins & Finley, 2000). World War II played a significant role in how Americans functioned with teams. While Americans were experimenting with different and new ways to model large organizations, the Japanese were working largely in teams and functioning well. Robbins and Finley (2000) stated,

> Through the 1970s word wafted across the Pacific Ocean of the new approach the Japanese were using. Instead of asking the least from the workers—such as tightening a 9/16-inch bolt 2 ¾ turns clockwise, over and over and over—the Japanese were asking the most. Every worker, in every function, at every level, was made a part of the company team. And the team's mission was continuous improvement of process. No idea was too small, and no worker was too small. Everyone participated. (p. 40)

Postwar American companies had become larger than ever, and the role of teams subsided. Managers were in charge of organizations, with management being the brains and workers being the muscle of the operation (Chi et al., 2011). During this time, this approach was seen as the best function for teams. By the 1960s, the literature shows that teams were not as serious a topic as they are now (Kruyt et al., 2011). Though they existed in organizations, teams were isolated within the organization. Teams were functional; managers devised areas, such as accounting teams or customer service teams,

in which everyone on the team pretty much did the same thing because they were all working on the same function toward the same goal.

By the 1990s, newer team models emerged. The focus in organizations was turned toward productivity of teams, restructuring of teams, and training and cost analysis based on the function of teams (Pentland, 2012). In the modern day, the idea of teams continues to evolve, though not as fast as technology. People are still developing new ideas and thoughts about how best to function as a group (Michael, 2012). Business is constantly changing and evolving, increasing in innovation. Teams are here to stay. They determine the way people work and the extent of the company's success (Robbins & Finley, 2000).

Like many roles within any organization, teams come in different forms. The type of team needed for an organization can vary; however, there are three distinctive types of teams: (a) organic teams, (b) project teams, and (c) nonorganic teams. Organic teams generally have a small set of team members. Teams are organized according to a common product, customer, or service (Michael, 2012). In an organic team, each member of the team has a position. Often, a counterpart system is used wherein team members can support one another. Therefore, organic teams typically are used in situations in which all the team members need to know how to carry out the same task (Michael, 2012). In contrast, project teams are teams that have members working on the same project. The members can be assigned to different groups and tasks within that project. Typically used in organizational structures, project teams are a collective group of individuals who work together toward a common goal. Project-type teams were the

focus of this study. Nonorganic teams are teams that are also in an organization but are put together for a particular task (Marincea & Dascãlu, 2011).

Teams not only differ in type but also in the conceptual framework surrounding the purpose of how the team functions within the organization. Teams are usually managed in accordance with the task(s) they are assigned. The conceptual framework of a team (particularly in hierarchical environments) comes down to two main areas: centralization of decision making and formalization of rules (Pentland, 2012). Centralization of decisions is a matter of how the power is utilized throughout the organization and how much say the team members have in their work, as well as whether employees get encouragement to participate in the decision-making process. The decision-making process can be high or low in centralization. If the centralization is high, then upper level employees make the decisions. If the centralization is low, all levels of employees may participate in the decision-making process, and they may even be encouraged to act on their own inclinations (Pentland, 2012). Formalization is a function of the norms within the organization. Formalization relates to the standardizations of the organization. An increase in formalization can have the potential to stifle productivity, as highly formalized environments could keep teams in a mode of noncreativity. In contrast, a low level of formalization could create chaos (Pentland, 2012).

Once the type of team and conceptual framework have been established for an organization, the team members must know how they can work together to be successful. Though "silos" may still exist in organizations, project teams within organizations need

to work in a much more structured way in accordance with the goals of the team to be successful (Robbins & Finley, 2000). Furthermore, team members cannot work so independently to the point that they are not communicating with members on their team. Communication is a key element to a team's success (Pentland, 2012). The point of establishing a team structure in an organization is for promoting success. Teams are not built for failure. Nevertheless, the literature on effective team functions reveals elements that can aid a team to be successful. The literature, however, does not address the degree to which each of the different elements is important to a team's success in the biotechnology industry specifically.

As Pisano (2006a) stated, well-organized, effective teams have not been in operation in the biotechnology industry. As the literature also revealed, the current system of how teams work in this industry has been causing setbacks for this important industry (Föller, 2002; IMAP, 2011). Therefore, ascertaining the elements of well-functioning teams for this industry is vital.

A review of the literature of chief authors in the area of effective team elements spanning the years 1960-2012 provided a mixture of eight major elements of a team's success:

1. The team has a clear purpose.
2. Performance goals are clear.
3. People are free to communicate (express their ideas).
4. Differences are acknowledged.
5. The team asks questions and listens.

6. The team forms organically at times.

7. Feedback is provided from time to time.

8. Challenging task goals that provide the team development are present.

This list was derived from the matrix in Appendix A. The matrix was created based on a review of literature from the past 50 years on the different elements of teams that make them effective. All of these elements play differing roles in the success of a team. However, the level of each that is needed for success for teams in the biotechnology industry is currently unknown. D. McGregor's (1960) focus was on creating work environments in which employees felt motivated. His research on this topic related to the elements needed for teams to be successful. Bolman and Deal (2008) continued in the same vein as McGregor, with a strong focus on teams and their work environments. Bolman and Deal expressed the importance of teams and their environments in saying,

> Much of the work in large organizations of every sort is now done in groups or teams. When these units work well, they elevate the performance of ordinary individuals to extraordinary heights. When teams malfunction, as often happens, they erode the potential contributions of even the most talented members. What determines how well groups perform? As illustrated by the surgical team, the commando team, and Al Quaeda, the performance of a small group depends heavily on structure. A key ingredient of a top-notch team is an appropriate blueprint of roles and relationships set in motion to attain common goals. (p. 101)

Similarly, D. McGregor (1960) believed that some elements could improve the environment in which teams work to help them stay focused and motivated.

Thomas Harvey and Bonita Drolet (2004) added a wide-ranging list of the elements of team effectiveness. They explained that times had changed from the early 1980s to the late 1990s, when technology had improved the function of communication

within organizations. Whereas managers primarily led teams prior to the 1980s, by the 1990s teams became somewhat self-led in the sense that the communication lines opened up between staff, loosening the structure of management over teams (Harvey & Drolet, 2004). This gradual change eventually led to understanding the elements of how teams function best in this evolving structured environment.

Ruth Wageman (2001) also provided a comprehensive list of elements for teams' success. Both Harvey and Drolet (2004) and Wageman (2001) focused more on the elements of the team than the organization, in contrast to Bolman and Deal (2008) and D. McGregor (1960). Wageman (2001) divided the elements into sections, such as direction of teams, enabling structures for teams, and supporting organizational context. Harvey and Drolet (2004) categorized their components similarly into different areas, such as norms, team building, and structure and content. These different components of the elements provided a clear direction for the elements being presented as well as clear information about exactly where each author believed the particular elements belonged. Harvey and Drolet placed the important effective team element of *clear purpose* in a section titled *structure and content*. Similarly, Wageman (2001) placed the same element in an area of her research entitled the *enabling structure*. This type of categorization gives the researcher a clear understanding of how to utilize those elements within a team environment. Assigning a team a clear purpose will give them structure and help them to be more effective in their task.

Pentland (2012) brought a modern-day perspective to a portion of the elements teams need to be successful, taking a different approach from that taken by the authors

who preceded her. Pentland looked at certain elements and separated them into subelements. Communication was divided into three subareas. Pentland viewed communication within teams as reflecting different patterns that can have different meanings at different times: "Patterns of communication, for example, explain why performance can vary so widely among seemingly identical teams" (p. 60). This method of taking a few elements and dividing them provided additional information and insight into how teams might view the different elements in different circumstances of their functions within the organization. Similarly, Harvey Robbins and Michael Finley (2000) used the method of taking the elements of successful teams and expanding them for different scopes of an organization. Like Pentland, Robbins and Finley showed how each element that they perceived as a success factor could be more than just a one-sided element of success. If the team members do not perceive elements in the same way in certain situations, the team's success could be jeopardized (Robbins & Finley, 2000).

J. Richard Hackman and Ruth Wageman (2005) highlighted the importance of team effectiveness being established early on within a team, because the more a team functions poorly, the more the company suffers. Moreover, Hackman noted, "Only when a company has eroded away 70 to 80 percent of its value, then they consider making real changes" (as cited in McCluskey, 1997, "Hurdles In Businesses," para. 4).

The authors of the literature on team success provided a robust view of the elements of team success in organizational environments. Team success complexities can vary among teams, depending on the structure of the team and the goals of that

particular team. The in-depth views of these authors provided valuable information regarding what individuals working in teams may view as necessary for their success.

Barriers to Team Success

Though teams can be very effective when used properly, they are not exempt from elements that can undermine success. Organizational leaders' knowledge of the barriers that teams face is important so that they can put the elements of success in place to combat the barriers as much as possible (Robbins & Finley, 2000). Caroselli (2011) suggested that barriers of teams often exist in the team members themselves:

> Potential barriers can be found in the nature of team members. If the team is composed of individuals vying for power and visibility, the team cannot reach collective success. In the ideal team, the objective takes precedence over individual priorities. Members can let go of their ego drive long enough to seek the synergy that's released when people are committed to collaborative interaction. (p. 56)

Though members of project teams can be brought together for their identified and established expertise, the performance element needed for the team's success is not always present within the team, creating barriers for team success (Gardner, 2009).

Knowing the barriers to a team's success is important so that they can be avoided, to avoid hindering the team's productivity. Multiple authors have researched this subject, arriving at a variety of common events that serve to block a team's success. Brodie (2009) provided a list of the five barriers to a team's success: fuzzy outcomes, unproductive conflict, playing it safe, individual agendas, and lack of leadership.

If a team is working in an environment that is results driven, then the outcomes that are expected of the team need to be clear and specific. A team cannot be successful

if it does not know the expectations for success. Conflict is natural among teams—even the strongest of teams are bound to have conflict. Some conflict can be healthy and result in positive outcomes. However, if the conflict is only focused on negative aspects within the team, then it is unproductive and can become a barrier to the team's success (Abbott et al., 2006). Taking risks might seem like a barrier. However, according to Brodie (2009), playing it too safe with teams can ultimately become a barrier if team members do not feel challenged. If certain aspects of the job become predictable to the team, then a culture might be formed within the team without boundaries. Changing direction in what is expected of the team may take the team members out of their safety zone (Senge & Wheatley, 2002). Individual agendas can also be barriers to a team's success (Caroselli, 2011). Brodie (2009) explained, "If a team is to prosper, all members need to sign up and be committed to the team goals" (para. 5). Brodie further explained that individual agendas are particularly challenging in businesses in which teamwork is important to success if multiple individuals are more focused on their personal success than they are on the success of the company. Leadership is important for teams, especially for results-driven teams. When a team does not have a leader, success is harder to achieve than when the team has the direction a leader can provide (Brodie, 2009).

Beer (as cited in Below, 2010) added to Brodie's (2009) list of common barriers within teams. First, not having a clear strategy among the team is a barrier to success. In addition, if a strategy is not clear within a team, this alone could lead to conflict among team members. An ineffective senior team is another barrier. The core management

team not bringing effective leadership to the team that is responsible for producing results can also be a barrier to success (Beer, as cited in Below, 2010). Beer stated that sometimes senior teams believe that merely stating what is expected of a team is enough leadership, but teams need to be guided throughout a function to know that they are on the right path to success (as cited in Below, 2010). Lack of communication is an additional barrier (Beer, as cited in Below, 2010). According to Beer, communication needs to come not only from the leaders but also from within the team itself (as cited in Below, 2010). He explained,

> What's at stake is the performance of the organization. . . . If an organization is experiencing these [communication] barriers, it would be ineffective and wouldn't be performing well. If you have designed the organization with cross-functional product development teams or they are ineffective, you can't develop new products. If you want a worldwide organization, and you have teams all over the world who are not working effectively together, and you don't have leadership at the top that is setting the priorities, staffing these teams properly or setting appropriate expectations for the teams, you are not going to accomplish what you want. (Beer, as cited in Below, 2010, para. 11)

Brodie (2011) also addressed the type of personal qualities of team members that can cause barriers within a team: lack of listening, being a "know it all," being a pessimist, not trusting, and promising highly but delivering lowly. Though communication can often be an issue within teams, so can a lack of listening. If one or more team members are not listening to pertinent instructions *or* not listening to ideas and thoughts from other team members, this inability could prohibit success for the whole team. The concept of leaders being aware of nonlisteners is important to ensure that the message gets across to all. If one person on the team feels superior to the others or has an answer to every question, this person could dominate the team and stifle others' abilities.

Pessimists can also be a barrier to the team because the potential worry about doing a task right could override the action of doing the function itself (Brodie, 2011).

Accomplishing a goal can be overwhelming. Some individuals might find working in a multiperson team environment to be a particular struggle. Having a member who is reluctant to move forward on tasks can be a barrier to the team as a whole. Though trust can take time to build within a team, an overall persistent lack of trust can be a barrier within a team. The recommended approach is to keep the trust going within the team and to handle any issues that might derail the trust within the team (Brodie, 2011). Teams are living systems that should not merely be given an action to accomplish with no direction. The variables that can stand in the way of a team's success can be complex and can derive not only from the source of a team working together but also from individual team members themselves (Brodie, 2011). Levi (2011) explained the most frequent reasons that barriers exist in teams. Though organizations experience benefits when teams are used, the barriers can often occur when the transition is made from working as a team to teamwork (moving from one team working together to working with other teams across the organization; Levi, 2011). The art of working within the confines of teamwork (teams working together) can create the barriers mentioned by Brodie (2011) and Beer (as cited in Below, 2010). Levi (2011) stated, "Effective work teams have norms that support high-quality performance and a level of group cohesiveness that provides social support for members" (p. 31). Beer added, "Though some leaders in organizations might know what the barriers are, it's the fact that they do not create an environment that allows discussion of the barriers that really hurts

performance" (as cited in Below, 2010, para. 13). Therefore, it is important for leaders not only to be aware of barriers within the team but also to communicate them among the team members to keep the barriers from infringing on the effectiveness of the team.

Summary

The literature review revealed that the following elements represent the consensus of researchers regarding the core elements of effective teams. Internal and external factors of the biotechnology industry affect teams and how they function effectively. The components of the industry can affect the team's performance in the organization as a whole. As seen in the literature from Harvey and Drolet (2004), organizations and the way they work have become more advanced in the last 100 years (Pentland, 2012). Teams are more in control of completing tasks to which they are assigned. Bolman and Deal (2008) highlighted the importance of a team having a clear blueprint for its task as a team. Wageman (2001) added to this idea by stating, "The purpose for the team needs to be clear and is about ends and not means" (p. 256). The authors in this field agreed with one another about the elements for success; however, the literature lacks direct information for biotechnology teams and their needs for success in this industry as working teams for the company to be able to thrive.

Though biotechnology companies are science-based businesses, at their core they are profit-making businesses like all other businesses. Therefore, teams are working in a dual environment of both a science-based business and the traditional organizational structure, as reviewed in the literature (Dewhurst et al., 2011). If competition continues

to increase among the companies, the products that the biotechnology industry has in its pipelines could become weaker as companies continue to compete against each other. When teams work in an effective manner, the mental models of the team match that effectiveness and, as Senge and Scharmer (2006) discussed, the brain acts as a self-organizing system that continues to draw from those experiences. This process highlights the importance of teams being effective both in biotechnology and in other industries. The work done by these companies, whether by big pharma or start-ups, is too important to avoid maintaining the momentum. Having effective teams will be key in helping to propel these companies forward and bring their products to market.

CHAPTER III

METHODOLOGY

> The scientist is not a person who gives the right answers; he's one who asks the right questions.
>
> —Claude Lévi-Strauss, *Mythologiques: The Raw and the Cooked*

The biotechnology industry is a field that is driven by innovation (Thorsteinsdóttir et al., 2011). However, not all success in the biotechnology industry comes from research conducted in laboratories. Biotechnology businesses have dual sides: the science side and the organizational business side (York et al., 2009). In the more successful biotechnology companies, both sides of the business work through a team structure.

Purpose of the Study

The first purpose of this study was to describe the perceptions of nonmanagerial cross-functional project team members working in the research and development (R&D) sector of biotechnology regarding which of the eight elements of teams' effectiveness are most important for success. The second purpose of the study was to examine the relationship between demographic characteristics of team members and those elements perceived as most important.

Research Questions and Hypotheses

Based on the extant literature, five research questions were used to guide this study. These research questions involved exploring the differences between team elements and demographic characteristics. Demographic characteristics were used as independent variables. The research questions were as follows:

1. To what degree do nonmanagerial cross-functional project team members working in biotechnology perceive that the eight elements of teams are important for success?
2. What do nonmanagerial cross-functional project team members working in biotechnology perceive as the single most important element of the eight elements of teams that are most important for success?
3. Is there a significant difference in perceived importance of team elements based on gender?
4. Is there a significant difference in perceived importance of team elements based on ethnicity?
5. Is there a significant difference in perceived importance of team elements based on years of experience in the biotechnology industry?

Table 2 provides a structured view of the five research hypotheses and related methodological components, including a dependent variable, three independent variables, and the statistical technique used to test each hypothesis. These methodological components appear here in brief and are discussed in depth later in this chapter.

Table 2

Hypotheses With Related Methodological Components

Hypothesis	DV	IV	Scale (DV, IV)	Statistics
H1	Team elements		Interval	Descriptive
H2	Team elements		Interval	Descriptive
H3	Team elements	Gender	Interval, Nominal	ANOVA
H4	Team elements	Ethnicity	Interval, Nominal	ANOVA
H5	Team elements	Experience	Interval, Nominal	ANOVA

Note. DV = dependent variable. IV = independent variable. ANOVA = analysis of variance.

Research Design

A quantitative, causal comparative, ex post facto design was used to guide this research. Causal comparative implies that the independent variables will cause the dependent variable to vary, while ex post facto refers to the fact that the independent variable will not be manipulated. This means that participants cannot be assigned to a group (e.g., gender group or age group). As defined, participants belonged to a group via where they worked within the organization rather than random placement (Dougherty, Shu-Yuan, McKenna, Seers, & Keeney, 2011).

Quantitative research provides numerical descriptions of trends or attitudes of an isolated portion of a population and involves attempts to generalize results to a larger sample of the same population (Creswell, 2008). It differs from qualitative research in that it involves accepting or rejecting a particular hypothesis through research. Quantitative research is more appropriate for answering questions about relationships or differences between specific variables than is qualitative research (Creswell, 2008).

Quantitative research was best suited for this study because the focus was to analyze data using descriptive statistics to summarize and compare the data among dependent and independent variables.

Operational Model

Three independent variables and a single dependent variable were specified, as shown in Figure 4. The first independent variable was gender (male or female). The second and third independent variables were ethnicity (minority and majority) and years of experience in the industry (less than 2 years, 2 to 5 years, and more than 5 years). The dependent variable was team elements.

Population, Sample, and Sampling Method

A population was defined by Creswell (2008) as a "group of individuals who have the same characteristics" (p. 151). Population is a general term for a larger group from which a sample to study derives. The goal is to generalize the data analysis and conclusions determined from the sample. Populations can be found in any geographical area and can be of any size (Gay, Mills, & Airasian, 2009). In addition, a target population is the group of individuals to whom the results of the study will be generalized (Creswell, 2008). Due to the large number typically found in the target population, the term used to describe subjects the researcher can realistically study is the accessible population (Gay et al., 2009).

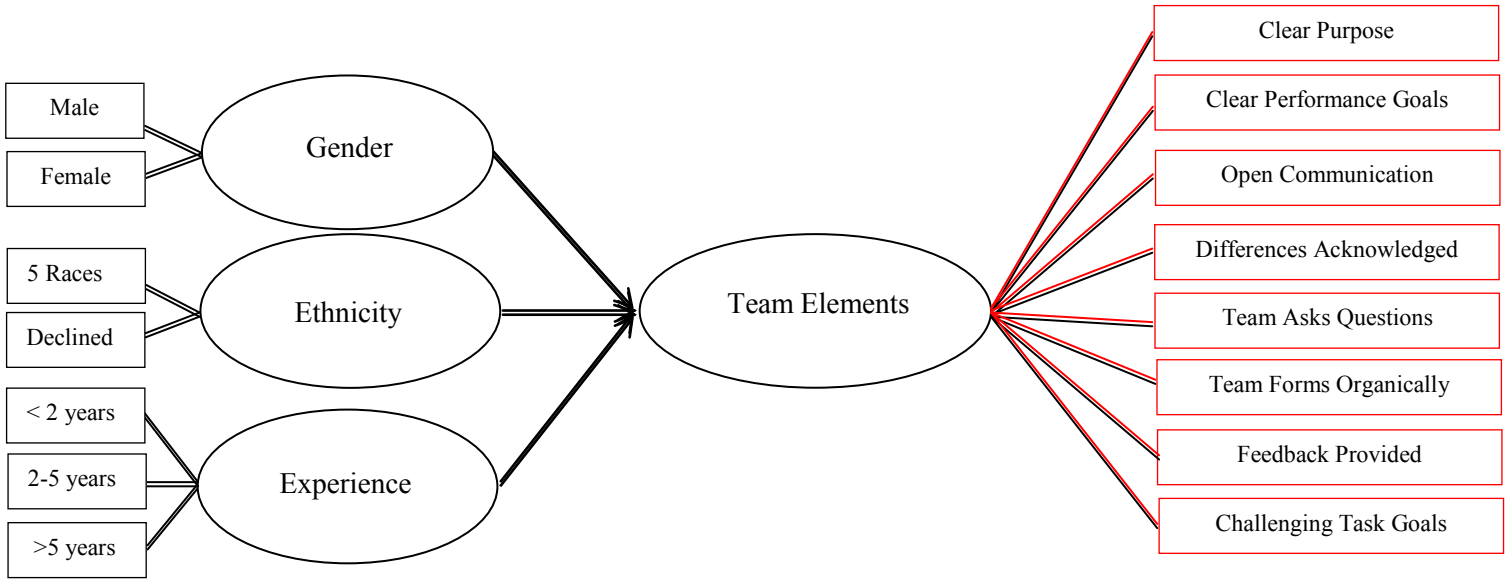

Figure 4. Model of hypothesized relationship between independent and dependent variables.

Within biotechnology companies, employees possess characteristics that enable them to work effectively within the industry. The population in this study consisted of full-time employees working in R&D departments within the biotechnology industry in Southern California. Approximately 1,466 biotechnology companies exist in the United States (Su, 2012). California has a large number of biotechnology companies (461; The Lab Rat, 2012). Of those 461 companies, 244 are in Southern California (BiotechCareerCenter, 2012).

Individuals working within the R&D department of a biotechnology organization typically have advanced degrees in areas such as bioinformatics, clinical research, forensic DNA, research associate, and science, as well as special training in good clinical practices (Frierman-Hunt & Solberg, 2008). Figure 5 depicts the skills and education required for R&D employees (Godbe Research, 2006). The set of skills that are listed as follows and shown in Figure 5 provides a description of the common characteristics of this population:

> According to responding companies, the most important skill when considering applicants for research associate positions was "Technical competence specific to the position" (69%), followed by the "Ability to work as part of a science team" (18%).
>
> For research associates, other important skills, knowledge, and abilities include:
>
> **Chemistry**—Knowledge of the chemical composition, structure, and properties of substances and of the chemical processes and transformations that they undergo. This includes uses of chemicals and their interactions, danger signs, production techniques, and disposal methods.
>
> **Biology**—Knowledge of plant and animal organisms, their tissues, cells, functions, interdependencies, and interactions with each other and the environment.
>
> **Physics**—Knowledge and prediction of physical principles, laws, their interrelationships, and applications to understanding fluid, material, and

atmospheric dynamics, and mechanical, atomic and subatomic structures and processes.

Mathematics—Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

Science—Using scientific rules and methods to solve problems.

Critical Thinking—Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Complex Problem Solving—Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Inductive Reasoning—The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events). (Godbe Research, 2006, p. 55)

Basic	Personal	Technical
Advanced math skills	Detail oriented	Analyze/evaluate technical data
Read and follow instructions	Manual dexterity	Biotechnology lab techniques
Written and oral communication	Observation skills	Computer skills
	Organizational skills	Knowledge of life sciences and chemistry
	Work as a team	Knowledge of SOPs, GMPs, and GLPs
	Work independently	Plan and carry out research
	Works well under pressure	Problem solving/critical thinking
		Read and interpret technical materials
		Record keeping skills
		Technical writing skills

Figure 5. Skills and education required for R&D employees. From *Biotechnology & Life Sciences Cluster Research*, by Godbe Research, 2006, p. 55, retrieved from http://www .niacreative.com/clients/w2f/LMI_Documents/work2future_Biotech_Report_10%5B1%5D .04.06.pdf.

The major focus of R&D employees is developing drugs for U.S. Food and Drug Administration (FDA) approval. Multiple stages are involved in development before a new drug can receive ultimate approval. R&D employees can work on those areas as a separate department, or they can work as a cross-functional team that requires collaboration with employees from other departments to accomplish a task.

Sample

A sample is a subset of individuals selected from a population. The purpose of this subset of individuals is to gain information from that group of the whole population (Hula, Fergadiotis, & Martin, 2012). According to Creswell and Plano Clark (2011), a sample needs to be large enough to meet the requirements for the chosen statistical tests. Creswell and Plano Clark also explained that the purpose of the sample is to develop an in-depth understanding from a few people when working with a large population.

Southern California was chosen for this study due to the number of employees who work in the R&D area of the biotechnology industry and due to its accessibility to the researcher. Creswell and Plano Clark (2011) defined an accessible population as follows:

> The population in research to which the researchers can apply their conclusions. This population is a subset of the target population and is also known as the study population. It is from the accessible population that researchers draw their samples. (pp. 182-183)

Within the 244 biotechnology companies located in Southern California, approximately 2,983 employees work in the R&D sectors (Godbe Research, 2006). Conducting research on the population would not be feasible; therefore, the research

sample was selected at 10% of the population of R&D employees in biotechnology companies in the Southern California area. The sample consisted of 1,230 (61%) of these full-time employees from biotech companies in Southern California; of that sample, 183 responded, a 15% response rate. According to Gay et al. (2009), in survey research, commonly 10% to 20% of the population is selected for a study.

Participants identified for this study were employees in the R&D departmental branch who were at least 18 years of age. It was assumed the demographic characteristics of the sample represented those of the population. Socioeconomic status was not a criterion for the sample.

Sampling Methodology

To extract the individuals sampled from the population, purposeful sampling was used. A purposeful sampling technique is one that allows the researcher to have access to the people in the population who can provide the most data about the topic. Purposeful sampling is the process whereby "the researcher intentionally selects (or recruits) participants who have experienced the central phenomenon or key concept being explored in the study" (Creswell & Plano Clark, 2011, p. 173). Purposeful sampling does have its limitations. It can be prone to researcher bias. The idea that purposeful sampling has been established based on the judgment and needs of the researcher is not a good defense when it comes to reducing probable researcher biases. However, this judgmental, subjective component of purposeful sampling is only a weakness when such judgments are poorly considered—that is, when judgments have not been based on clear

criteria, whether a theoretical framework, expert elicitation, or some other accepted criteria. Despite its limitations, purposeful sampling is the best method of obtaining a sample population when specific criteria are essential. For this research, purposeful sampling was employed due to the population within the biotechnology industry required. Many departments exist within a biotechnology company, and R&D is one. Purposeful sampling was needed to identify those individuals who worked in the R&D area only.

Inclusion

Participants in this study were required to be full-time employees in R&D departments of biotechnology companies. Participants had to be working in organizations that had been in business for at least 1 year with a minimum of 100 employees. Participants had to work in an environment with team structures that focused on drug development, an entrepreneurial research atmosphere, a strong ethos in collaboration, and professionalism that was due to the importance of the work. According to Li and Halal (2002), "Teams [in biotechnology] should be allowed almost complete freedom to choose their goals, supporting technology, personnel, working hours, resources, and almost all other aspects of their projects—exactly the same conditions in which entrepreneurs thrive" ("A New Management Model," para. 4).

Exclusion

Excluded from the sample were individuals who were not full-time employees in the biotechnology industry. Additionally, employees who were less than 18 years of age and who did not work in the R&D area of a biotechnology company with the specified

team structure were excluded from the study. Ethnicity, gender, and socioeconomic status were not conditions of exclusion.

Power Analysis

A priori sample size determination is assessed by conducting a formal power analysis (Dougherty et al., 2011). Three factors are taken into consideration when conducting the analysis, including the intended power of the study, the effect size of the phenomenon under study, and the level of significance to be used in rejecting the null hypotheses (alpha). Study power is the probability of rejecting a false null hypothesis. As a matter of convention, adequate power to reject a false null hypothesis is .80 (Kuehl, 2000). Effect size is an estimated measurement of the strength of the relationship between variables in the study (Cohen, 1992). Cohen (1992) specified the effect size, Cohen's f^2, as being small, medium, or large, in which each level is associated with a specified effect size. Thus, a small effect would be .10, medium would be .25, and large would be .40.

Alpha is the level of confidence in rejecting the null hypothesis. According to social science research convention, alpha is set at .05. The following parameters were used in this study: (a) test model = analysis of variance (ANOVA)—fixed effects, omnibus, one-way; (b) power = .80; (c) effect size = .25; and (d) alpha = .05. The sample size required was 159 participants (Faul, Erdfelder, Lang, & Buchner, 2007).

Data Collection

According to Creswell and Plano Clark (2011), "The basic idea of collecting data in any research study is to gather information to address the questions being asked in the study" (p. 171). The researcher first contacted biotechnology companies that fit the profile of an organization, as displayed in Appendix B. The companies' key decision makers, such as directors or managers, were contacted via e-mail. Follow-up e-mails were sent when e-mail messages received no response after 1 week. (A sample of the e-mail message sent to the managers appears in Appendix C.) In the e-mail message, the directors or managers were asked to select employees to participate in the survey and to send them an enclosed e-mail (Appendix D) that was a letter from the researcher to the participants. Once the managers' approval was received, managers were asked to identify participants suited for the study. Managers then forwarded a letter to participants via e-mail with a link to the online community, ZipSurvey. ZipSurvey is a private American company that enables users to create their own web-based surveys and upload already published surveys. It allows users to design surveys, collect responses, and analyze the responses to their surveys. The e-mail message sent to participants contained the informed consent form explaining the purpose of the study and the nature of the participants' involvement (see Appendix E). In addition, potential participants were assured that no identifying information would be used or collected at any point during the process and that all results would remain anonymous.

Prior to permission being granted verbally or via e-mail from these key decision makers, an application was submitted to the University of La Verne's Institutional

Review Board. This application indicated that the proposed research did not include a population considered vulnerable and that the participants would not be subjected to any risk. Upon the approval from the Institutional Review Board (Appendix F), the process of conducting the research at the selected biotechnology companies commenced.

Data were collected from 183 full-time employees who worked in the R&D sections of various biotechnology companies located in Southern California. Selection of the companies chosen to participate in this survey occurred using the private company Bio Pharmaguy, which has created a database of all biotech companies in California. The list enables individuals who work in the biotech industry to contact the companies for employment opportunities. The researcher contacted the owner of Bio Pharmaguy (see Appendix G) to obtain a listing of the biotechnology companies in Southern California. The database contained the names, locations, and contact information (direct-line phone numbers and e-mail addresses) of managers within the R&D departments of these companies. The researcher used this database to contact the company managers to request approval for participation in the study, using a random sampling tool in Excel.

The criteria for selection of the biotechnology companies used in this study appear in Appendix B. The chart shows six major components relating to the inner workings of a biotechnology company: management and business development, information technology, product R&D, testing new products, manufacturing, and customers. For this study, the group of teams chosen was from the Testing New Products in Clinical Trials R&D branch of the organizations. This portion of the population within

biotech companies best represented the elements of teams needed for the purpose of this study.

The researcher uploaded the demographic survey and the Effective Teams in Biotechnology Industry Survey (Appendix H) to ZipSurvey. The survey instrument used was created for this study. The participant demographic survey contained three items. Demographic variables were scaled at the nominal level. The Effective Teams in Biotechnology Industry Survey was a 20-item instrument assessing participants' perceptions of the importance of team elements. Items on the Effective Teams in Biotechnology Industry survey were measured at the interval level, with responses ranging from 1 to 4. In this case, 1 = *strongly disagree*, 2 = *somewhat disagree*, 3 = *somewhat agree*, and 4 = *strongly agree*.

Prior to completing the surveys, each participant read an informed consent form and clicked "agree." If a participant refused to agree with the informed consent form, he or she was automatically removed from the study. After indicating agreement with the informed consent form, each participant completed the demographic portion of the survey and the full survey titled Effective Teams in Biotechnology Industry. All data were collected and recorded using Microsoft Excel. In addition, the Statistical Package for the Social Sciences (SPSS) software program was used to analyze the data.

Data Security

Data were stored in a secure electronic file using a password to restrict access. Personal data were not collected or linked to participants' survey responses. Data were

used in accordance with acceptable research procedures (i.e., only data in aggregate form were published).

Operationalization of Variables

Four variables were specified in the theoretical model, including one dependent variable and three independent variables. The independent variables were gender, ethnicity, and experience. The dependent variable was team elements.

Dependent Variable

Team elements were operationalized as day-to-day functions that would utilize one or more of the selected team elements. This variable comprised eight team elements: (a) clear purpose, (b) clear performance goals, (c) free communication and expression of ideas, (d) acknowledged differences, (e) questioning, (f) organic formed teams, (g) provided feedback, and (h) challenging task goals that provide team development.

Data were collected via the Effective Teams in Biotechnology Industry Survey. Questions 1 to 20 on the survey were used to measure the dependent variable, team elements. This variable was scaled at the interval level where a 4-point Likert-type scale ranged from low to high: 1 = *strongly disagree*, 2 = *somewhat disagree*, 3 = *somewhat agree*, and 4 = *strongly agree*. As evidenced by the scale, no escape option was available to respondents.

Independent Variables

Gender, for the purpose of this study, was the state of being either male or female. Gender data were collected via a single question on the demographic survey. Question 1 on the demographic survey collected these data. Gender had a nominal scale, with scores being 1 = *male* or 2 = *female*.

Ethnicity was operationalized as groups of people who identify with other people through a common heritage, consisting of a common culture (Cox & Cox, 2008). The groups examined in this study were African American, Caucasian, Hispanic, Asian, and other. Ethnicity was measured using a single question on the demographic survey. The variable had a nominal scale.

Experience was operationalized as how long an employee worked at a company. Data for the variable were collected via a single question on the demographic survey. This variable had a ratio scale, with scores scaled as 1 = *less than two years*, 2 = *two to five years*, and 3 = *more than five years*.

Instrumentation

To conduct a study, the researcher needs an instrument that is both valid and reliable (Creswell & Plano Clark, 2011). In their book, *Your Opinion Please! How to Build the Best Questionnaires in the Field of Education*, Cox and Cox (2008) described a survey as an instrument that allows the researcher to collect information from participants. The survey in this study (Appendix H) consisted of three sections with questions that had identifiable, observable characteristics. Cox and Cox explained that "it

becomes necessary to identify *observable* characteristics to leadership skills in some other way and to use those specific characteristics in the questionnaire items rather than the general term *leadership*" (p. 7) when it is possible that one person views leadership skills one way and another in a different way. The 20-item survey had three sections in accordance with the eight elements identified in the literature as characteristics of a successful team. The survey distributed these eight elements among the following three sections: objectives, roles, and core mission (vision and value). A Likert-type scale was used, with 1 = *strongly disagree*, 2 = *somewhat disagree*, 3 = *somewhat agree*, and 4 = *strongly agree*. Because this was a quantitative study, the survey questions in the instrument were closed-ended.

Cox and Cox (2008) suggested that before collecting data, appropriate steps should be taken to ensure that the data collected are credible. Cox and Cox mentioned three areas specifically: first, the intended content must be valid; second, the instrument(s) must elicit accurate information; and third, the instrument(s) must measure consistently. To establish content validity, the content of the instrument was checked by cross-referencing the elements reported in the literature, and the content was also reviewed by a statistician. This approach allowed for determination of whether the instrument addressed the topic of the study. The elements in Appendix B provide the structural elements of the environments in which teams that participated in the survey would be working.

Reliability

A pilot study of 10 R&D employees was conducted to measure the internal consistency reliability of the Effective Teams in Biotechnology Industry Survey. Each of the 10 employees completed the questionnaire. The data were analyzed using Cronbach's alpha. If Cronbach's alpha was greater than .7, then the construct measuring the team elements was considered reliable. The pilot proved to be reliable in that participants did not identify any factors of the survey that prohibited them from providing responses.

Data Analysis

Descriptive statistics were used to assess Research Questions 1 and 2. Descriptive statistics are

> a set of brief descriptive coefficients that summarizes a given data set, which can either be a representation of the entire population or a sample. The measures used to describe the data set are measures of central tendency and measures of variability or dispersion. (Thomas, 2011, p. 517)

An ANOVA was used to assess Research Questions 3 to 5. The ANOVA technique provided a means for the researcher to test if demographic characteristics affected the dependent variable. This process allowed for statistical testing not only across the different questions but also between levels of the independent variables. One dependent variable, team elements, was used in each of the three hypotheses as described below.

An ANOVA was used for comparison of two or more means. The comparison revealed whether any significant differences between the variables existed (Tabachnick &

Fidell, 2007). This type of analysis was used to test Hypotheses 1 to 3. The dependent variable for Hypotheses 1 to 3 was team elements. The independent variable for Hypothesis 1 was gender (male or female). The independent variable for Hypothesis 2 was ethnicity (minority and majority), and the independent variable for Hypothesis 3 was experience (less than 2 years, 2 to 5 years, and more than 5 years).

Ethical Considerations

Ethical concerns for this study included (a) individuals participating in the study did so of their own accord, (b) they provided data that were accurate and honest, and (c) participants followed directions when responding to the self-assessment instrument used for data collection. Additional ethical concerns included confidentiality, informed consent, voluntary participation, and risks and benefits to the participants.

Confidentiality

No individually identifiable information was disclosed or published, and the presentation of all results is as aggregate, summary data. The information was kept confidential and secure by design. All aggregate data will be stored in a secured file for a minimum of 3 years and then permanently destroyed. If any content is published, it will be done for scientific purposes only. That is, data will be used to further the cause of science rather than for personal reasons.

Informed Consent

The respondents' participation in the study was strictly voluntary and did not present any risks or benefits resulting from their participation. The informed consent form contained a statement that participation in the study was strictly voluntary and confidential. In addition, the participants had the right to choose to decline to complete the study at any time, and all participants confirmed that they were at least 18 years of age. The letter of intent detailed the structure of the study and stated that no risks or benefits would result from participation in the study. It also included assurance of confidentiality regarding the participants' involvement in the study.

Voluntary Participation

Participation was voluntary, and refusal to participate involved no penalty or loss of benefits. Participants had the right to discontinue participation at any time without penalty or recourse.

Limitations and Delimitations

Although applying the results of the study to the population may be appropriate, it may not provide an accurate depiction of all biotechnology employees in other parts of the United States. Unknown variables in the study could have affected responses and may have influenced the outcome of the results of participants.

Summary

This quantitative study was designed to explore the differences in perceived importance of team elements by gender, ethnicity, and experience. This chapter included a description of the research methodology used to accomplish this purpose. In addition, this chapter also included a description of the sample, data collection procedures, and data interpretation and analysis.

Chapter IV includes a description of the data collected, the data analysis procedures, and the results of the study as they pertain to the hypotheses and research questions.

CHAPTER IV

ANALYSIS OF THE DATA

> Rather than believe that Watson and Crick made the DNA structure, I would rather stress that the structure made Watson and Crick.
>
> —Francis Crick, "What Mad Pursuit"

This chapter details the purpose statement, reviews the research questions, describes the population and sample, provides an analysis of the data for each research question, and describes the findings.

Purpose of the Study

The first purpose of this study was to describe the perceptions of nonmanagerial cross-functional project team members working in the research and development (R&D) sector of biotechnology regarding which of the eight elements of teams' effectiveness are most important for success. The second purpose of the study was to examine the relationship between demographic characteristics of team members and those elements perceived as most important.

Research Questions

The following research questions were developed for this study:

1. To what degree do nonmanagerial cross-functional project team members working in biotechnology perceive that the eight elements of teams are important for success?
2. What do nonmanagerial cross-functional project team members working in biotechnology perceive as the single most important element of the eight elements of teams that are most important for success?
3. Is there a significant difference in perceived importance of team elements based on gender?
4. Is there a significant difference in perceived importance of team elements based on ethnicity?
5. Is there a significant difference in perceived importance of team elements based on years of experience in the biotechnology industry?

The following hypotheses pertained to Research Questions 3 to 5:

1. There is no significant difference in perceived importance of team elements by gender (male or female).
2. There is no significant difference in perceived importance of team elements between majority individuals and minority individuals.
3. There is no significant difference in perceived importance of team elements among those with different years of experience.

Population and Description of the Sample

The population in this study consisted of full-time employees working in R&D departments within the biotechnology industry in Southern California. For the purpose of

this study, Southern California was chosen due to the number of employees who work in the R&D area of the industry and due to its accessibility to the researcher. A purposeful sample was used to reach potential participants. The population for this study consisted of 2,983 biotechnology employees. Of those, 1,230 were sent an invitation to participate in the survey. Of those invited to participate, 183 participated in the survey, for a response rate of 15% of those who were invited to participate. The researcher was not able to receive responses from 10% of the population, which was anticipated because the researcher was not in direct communication with the population. Creswell (2008) defined such situations as convenience sampling, "a quantitative sampling procedure in which the researcher selects participants because they are willing and available to be studied" (p. 638). The researcher was able to narrow the population by only selecting participants who worked in biotechnology companies in the Southern California area, thus ensuring that those who did respond were an appropriate representation of the target population.

Analysis of Data

Each of the participants responded to a total of 20 questions specific to elements that have been identified as creating effective teams in the biotechnology industry, using a 4-point Likert agreement scale (1 = *strongly disagree*, 2 = *somewhat disagree*, 3 = *somewhat agree*, 4 = *strongly agree*). In addition, the participants were asked three demographic questions. This study used descriptive and inferential statistical tests to answer the research questions. SPSS was used to analyze the data using descriptive statistics, including frequencies, means, and standard deviations.

Indexes were created to assess the four overall elements (objectives, roles, organizational structure, and elements of working in a team). The researcher tested the variables that were placed in each index by using a Reliability Analysis Scale test, which tests the strength of the internal consistency between the variables and how closely related the items are as a group.

Comparisons of the differences in the mean scores for gender were made for each of the statements using the independent-samples *t* test. Comparisons of the differences in the mean scores for ethnicity and years having worked in the biotech/pharmaceutical industry were made using the one-way analysis of variance (ANOVA) test.

Demographic Information

Tables 3 through 5 reflect the results for the three demographic questions on the survey. Although 183 individuals responded to the survey, two respondents chose not to provide their personal information in the demographics section (1.1% of the sample). The percentages of each response type portrayed are based on the number of participants who answered the demographic questions.

Percentage of Response by Gender

Table 3 illustrates the distribution of respondents by gender. Responses by gender were fairly evenly distributed, with just under half of responses (46%) coming from male participants and 54% of responses coming from females.

Table 3

Sample Population by Gender

Gender	Number	% of respondents
Male	83	45.9%
Female	98	54.1%

Percentage of Response by Ethnicity

The distribution of participants by ethnicity is displayed in Table 4. Half of the participating respondents were Caucasian (51%). The next largest groups, following in order of response rate, were Asians (17%), African Americans (16%), and Hispanics/ Latinos (12%). Four percent of respondents selected "other," and 2% selected "decline to answer."

Table 4

Sample Population by Ethnicity

Ethnicity	Number	% of respondents
African American	28	15.5%
Asian	30	16.6%
Caucasian	92	50.8%
Hispanic/Latino	21	11.6%
Other	7	3.9%
Decline to answer	3	1.7%

Percentage of Response by Years Working in the Biotech/ Pharmaceutical Industry

Table 5 provides the distribution of participants by the number of years they had worked in the biotech/pharmaceutical industry. Just over half of the respondents (54%) said they had been in the industry for more than 5 years. Close to one in three participants (30%) had been in the industry between 2 and 5 years, and 16% had been in the industry less than 2 years.

Table 5

Sample Population by Number of Years Working in the Biotech/Pharmaceutical Industry

Years in biotech industry	Number	% of respondents
Less than 2 years	28	15.5%
2 to 5 years	55	30.4%
More than 5 years	98	54.1%

Survey Results

Research Question 1

To what degree do nonmanagerial cross-functional project team members working in biotechnology perceive that the eight elements of teams are important for success?

The first section of the survey asked participants to rate the extent to which they agreed or disagreed with statements about *objectives*, and it contained six statements. The next section of the survey asked participants to rate the extent to which they agreed

or disagreed with statements about *roles*. This section was made up of five statements for evaluation. The third section asked participants to rate the extent to which they agreed or disagreed with statements about *organizational structure*, which included four statements. The final section asked participants to rate the extent to which they agreed or disagreed with statements about *elements of working in a team*. This section was made up of four statements. All of these questions utilized the same 4-point Likert agreement scale. The response options for this Likert scale were labeled as shown in Table 6.

Table 6

Agreement Scale

Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
1	2	3	4

Mean scores for the 19 statements were calculated and are arranged in order by descending mean in Table 7. A combined percentage of *somewhat agree* and *strongly agree* responses for each statement is also presented in the table. As this table illustrates, the three statements that achieved the highest levels of agreement, each with a mean score of over 3.20 were "I feel challenged in my role within my team" ($M = 3.23$), "my team has goals that we work towards" ($M = 3.22$), and "working in a science-based industry I feel the need to have a science-based background to succeed" ($M = 3.21$). At least four out of five participants agreed with each of these statements (between 80% for

"I feel challenged in my role within my team" and 84% for "my team has goals that we work towards").

The statements that achieved the lowest levels of participant agreement were "I am clear about the role of others on my team," "the whole team contributes to the objectives," and "there is little to no overlap in roles on my team." These statements had mean scores between 2.55 and 2.59, which is about halfway between the level of *somewhat disagree* and *somewhat agree*. Additionally, just over half of participants agreed with these statements (51%, 54%, and 57%, respectively). Other statements that received lower ratings were "I think my team received satisfactory training and information that pertains to our work in order for us to succeed," receiving a mean score of 2.63 and agreement from 59% of participants, and "my team has the right people filling the necessary roles" ($M = 2.75$, 69% agreement).

In order to look at the four overall topics that made up the first part of the survey, the researcher created elements (categories of working in teams) of overarching topics by combining the statements in the questionnaire. These specific statements that made up each index are identified in Table 8.

The researcher then tested each index using a Reliability Analysis Scale test, with Cronbach's alpha test, which examined the strength of the internal consistency between the variables and how closely related the items are as a group. The closer Cronbach's alpha coefficient was to 1.0, the greater the internal consistency of the items on the scale

Table 7

Agreement With Elements of Effective Teams

Elements of effective teams	Number	% somewhat & strongly agree	*M*	*SD*
17. I feel challenged in my role within my team	179	79.9%	3.23	0.847
6. My team has goals that we work towards	182	84.1%	3.22	0.748
12. Working in a science-based industry I feel the need to have a science-based background to succeed	179	82.7%	3.21	0.807
1. I understand our team's objectives	183	80.3%	3.18	0.738
16. I feel comfortable expressing my ideas in my team work environment	180	83.3%	3.13	0.750
19. My team meets to discuss action plans when needed	180	75.6%	3.11	0.851
8. I am clear about my role within the team	180	75.0%	3.04	0.877
13. Being focused on innovation is important in my role	179	73.7%	3.03	0.807
2. Our objectives are in writing	182	68.7%	2.89	0.916
15. I feel the work processes we have in place are helpful so that I can fulfill my job	180	70.6%	2.88	0.827
18. I feel I receive proper feedback from my manager for the work I do within my team	180	66.1%	2.85	0.906
3. Our objectives are measureable	182	65.9%	2.84	0.978
5. Our objectives are science-based	183	66.1%	2.82	0.868
9. Everyone on my team is held accountable for performing tasks	181	59.7%	2.81	0.920
7. My team has the right people filling the necessary roles	181	68.5%	2.76	0.758
14. I think my team received satisfactory training and information that pertains to our work in order for us to succeed	180	59.4%	2.63	0.921
11. There is little to no overlap in roles on my team	180	56.7%	2.59	0.883
4. The whole team contributes to the objectives	183	53.6%	2.57	1.008
10. I am clear about the role of others on my team	179	51.4%	2.55	1.055

Note. The number of responses for the 19 statements varied. This occurred because some respondents chose not to respond to all 19 statements for this series of questions. The actual number of participants responding to each statement is provided in the table.

Table 8

Elements Descriptions

Index	Statements
Objectives	• I understand our team's objectives. • Our objectives are in writing. • Our objectives are measureable. • The whole team contributes to the objectives. • Our objectives are science-based. • My team has goals that we work towards.
Roles	• My team has the right people filling the necessary roles. • I am clear about my role within the team. • Everyone on my team is held accountable for performing tasks. • I am clear about the role of others on my team. • There is little to no overlap in roles on my team.
Organizational structure	• Working in a science-based industry, I feel the need to have a science-based background to succeed. • Being focused on innovation is important in my role. • I think my team received satisfactory training and information that pertains to our work in order for us to succeed. • I feel the work processes we have in place are helpful so that I can fulfill my job.
Elements of working in a team	• I feel comfortable expressing my ideas in my team work environment. • I feel challenged in my role within my team. • I feel I receive proper feedback from my manager for the work I do within my team. • My team meets to discuss action plans when needed.

and the more appropriate it was to create an index including them. George and Mallery (2003) provided the following rules of thumb: "_ > .9 = Excellent, _ > .8 = Good, _ > .7 = Acceptable, _ > .6 = Questionable, _ > .5 = Poor, and _ < .5 = Unacceptable" (p. 231). For the purpose of this study, the researcher used the rule of thumb to set the

acceptable level of internal consistency at around .7 or greater. Table 9 portrays the level of internal consistency for each index created. Because the alpha coefficient for objectives and roles was greater than .7, the researcher felt confident about grouping the statements in each of these indexes into one overarching category. On the other hand, organizational structure and elements of working in a team both fell below an alpha level of .7, which indicates that the statements within the indexes are not as closely related as those in the objectives index and roles index. Caution, therefore, must be exercised when interpreting the definitions of these two indexes.

Table 9

Internal Consistency for Indexes

Index	Number of statements in index	Cronbach's alpha coefficient
Objectives	6	.759
Roles	5	.738
Organizational structure	4	.448
Elements of working in a team	4	.631

When all of the statements that made up each element were taken together and analyzed by element, Table 10 shows that, on average, statements specific to working in a team received the highest agreement scores, falling above a level of *somewhat agree* at 3.08 (76% combined agreement). This was followed by statements specific to organizational structure ($M = 2.94$, 72% agreement) and statements regarding objectives ($M = 2.92$, 70% agreement). The overall topic least likely to be agreed with by

participants contained the statements associated with roles ($M = 2.75$, 62% combined agreement score).

Table 10

Agreement With Elements of Effective Teams—Overall Categories

Elements of effective teams	% somewhat & strongly agree	*M*
Objectives	69.8%	2.92
Roles	62.3%	2.75
Organizational structure	71.6%	2.94
Elements of working in a team	76.3%	3.08

Research Question 2

What do nonmanagerial cross-functional project team members working in biotechnology perceive as the single most important element of the eight elements of teams that are most important for success?

Survey Question 20 asked participants, "Which *single* element of those listed below do you personally feel is *most* important to the success of working in a team in the biotech/pharmaceutical industry?" and provided a list of eight elements that have been found to contribute to team success. Table 11 portrays the results of this inquiry. "Having a team that communicates as needed to discuss any issues that come up" was selected as the most important element by 19% of respondents. This was followed by "having a clear purpose," which was selected by almost 16% of survey participants. The three elements that were selected as most important by the least number of participants

were "having a team that asks questions" (selected as most important by only 6% of all respondents), "receiving feedback from leaders of the team" (selected by 9%), and "feeling that I am gaining personal development in my role as a team member" (selected by 9%). It should be noted that "having a clear purpose" (selected as most important by 15.6% of participants) and "having clear performance goals" (selected by 13.3%), two closely related elements, constituted a combined 28.9% of responses.

Table 11

Most Important Team Element

Element	Number	% of respondents
Having a clear purpose	**28**	**15.6%**
Having clear performance goals	24	13.3%
Having the freedom to communicate	25	13.9%
Knowing that my ideas are acknowledged	25	13.9%
Having a team that asks questions	10	5.6%
Having a team that communicates as needed to discuss any issues that come up	**35**	**19.4%**
Receiving feedback from leaders of the team	16	8.9%
Feeling that I am gaining personal development in my role as a team member	17	9.4%

Note. Three participants (1.6%) did not respond to this question.

Research Question 3

Is there a significant difference in perceived importance of team elements based on gender?

After analyzing the responses to Survey Question 20, the researcher then analyzed these data by each of the demographic questions in order to determine if statistically significant differences existed. With regard to gender, the largest difference between male and female respondents was with the selection of "having a team that communicates as needed to discuss any issues that come up" as the most important element (difference of 11.4%). Female respondents were more likely to select this as their top pick (see Table 12). However, because the Pearson's chi-square result was greater than .05, the difference between these groups was not statistically significant. Therefore, the null hypothesis was accepted for this comparison.

Table 12

Most Important Element—Comparison by Gender

Element	Male	Female
Having a clear purpose	14.5%	16.5%
Having clear performance goals	13.3%	13.4%
Having the freedom to communicate	13.3%	14.4%
Knowing that my ideas are acknowledged	14.5%	13.4%
Having a team that asks questions	10.8%	1.0%
Having a team that communicates as needed to discuss any issues that come up	13.3%	24.7%
Receiving feedback from leaders of the team	7.2%	10.3%
Feeling that I am gaining personal development in my role as a team member	13.3%	6.2%

Note. Pearson chi-square two-sided significance = .054.

Research Question 4

Is there a significant difference in perceived importance of team elements based on ethnicity?

Table 13 portrays the differences in responses to Survey Question 20 based on ethnicity. With regard to ethnicity, the differences between the ethnic respondents were that African Americans had a higher level of response to freedom of communication, Caucasians and Hispanics/Latinos had a higher response to overall communication within their teams, and Asians responded highly to wanting to receive feedback from their leaders, as shown in Table 13. The responses did not vary much percentage-wise, however, because the Pearson's chi-square result was greater than .05, indicating that the difference between these groups was not statistically significant. Therefore, the null hypothesis was accepted for this comparison.

Research Question 5

Is there a significant difference in perceived importance of team elements based on years of experience in the biotechnology industry?

Table 14 is the breakdown of the most important elements that participants chose based on how many years they had been in the biotechnology industry. Gaining personal development in the workplace, communication, and having a clear purpose were rated high among respondents overall. Those with more than 5 years in the industry did rank communication as the most important, whereas receiving feedback from team leaders was more critical to those with less than 2 years of experience in the industry.

Table 13

Most Important Element—Comparison by Ethnicity

Element	African American	Asian	Caucasian	Hispanic/ Latino	Other
Having a clear purpose	10.7%	13.3%	22.0%	-	-
Having clear performance goals	10.7%	13.3%	15.4%	14.3%	-
Having the freedom to communicate	17.9%	10.0%	11.0%	9.5%	57.1%
Knowing that my ideas are acknowledged	14.3%	10.0%	11.0%	33.3%	14.3%
Having a team that asks questions	7.1%	6.7%	4.4%	9.5%	-
Having a team that communicates as needed to discuss any issues that come up	14.3%	16.7%	25.3%	9.5%	14.3%
Receiving feedback from leaders of the team	7.1%	20.0%	6.6%	9.5%	-
Feeling that I am gaining personal development in my role as a team member	17.9%	10.0%	4.4%	14.3%	14.3%

Note. Pearson chi-square two-sided significance = .046.

Summary

This study provided quantitative data on a group of individuals who worked in biotechnology companies and their assessment of elements that lead to effective teams. The statements included in this survey were related to four categories of elements that were identified by the researcher as contributing to the success of teams (objectives, roles, organizational structure, and elements of working in a team). The data collection involved an online survey with 183 survey participants.

Table 14

Most Important Element—Comparison by Years of Biotech/Pharmaceutical Industry Experience

Element	Less than 2 years	2 to 5 years	More than 5 years
Having a clear purpose	14.3%	10.9%	18.6%
Having clear performance goals	14.3%	12.7%	13.4%
Having the freedom to communicate	10.7%	12.7%	15.5%
Knowing that my ideas are acknowledged	17.9%	18.2%	10.3%
Having a team that asks questions	3.6%	9.1%	4.1%
Having a team that communicates as needed to discuss any issues that come up	14.3%	12.7%	24.7%
Receiving feedback from leaders of the team	21.4%	9.1%	5.2%
Feeling that I am gaining personal development in my role as a team member	3.6%	14.5%	8.2%

Note. Pearson chi-square two-sided significance = .217.

In conducting the data analysis, the researcher used descriptive and inferential statistical tests to answer the research questions. Specifically, frequencies, means, standard deviations, and mean comparisons using the independent-samples *t* test and one-way ANOVA were employed. The research findings were presented for each research question, and statistically significant differences were pointed out where applicable.

Chapter V includes an overview of the study, interpretation of the findings, implications of the findings, limitations of the study, and suggestions for future research.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

> New discoveries in science will continue to create a thousand new frontiers for those who still would adventure.
>
> —Herbert Hoover, *Addresses Upon the American Road, 1955-1960*

Chapter V begins with an overview of the problem, followed by the purpose statement and methodology that guided the research. The major findings from the study are presented, as well as conclusions and suggestions for action. The chapter concludes with recommendations for further research, ending with reflections about the study from the researcher.

Summary of the Study

Overview of the Problem

Teams are everywhere in the workplace, and the biotechnology industry is no exception to this. The biotechnology industry uses teams in an organic way in that the industry lends itself to teamwork. In order to produce a blockbuster drug, biotechnology companies must work through phases to get the drug to approval. Each phase must be accomplished by teams of people properly performing their roles in order to reach the next phase (Föller, 2002). These teams can be made up of individuals with different demographic characteristics and with varying levels of experience in the industry (Pisano,

2006a). This dynamic could add to the stress of the team if elements of team success are not known. With the potential biotechnology companies have of making drugs or medical devices that can aid those who need the medications produced by those companies, it is imperative that teams work together in the most effective manner possible. Competition in this industry is always looming in the background, therefore making it crucial for companies to work efficiently to avoid rework, which can cost valuable time and money. The research and development (R&D) sector of each biotechnology company holds a great responsibility in developing drugs to market phase. Elements of team success have been studied over the years, but not directly within this industry.

Purpose of the Study

The first purpose of this study was to describe the perceptions of nonmanagerial cross-functional project team members working in the R&D sector of biotechnology regarding which of the eight elements of teams' effectiveness are most important for success. The second purpose of the study was to examine the relationship between demographic characteristics of team members and those elements perceived as most important.

Methodology

One hundred eighty-three participants in the biotechnology industry in Southern California were randomly selected to participate in an online survey asking questions about the elements that they consider important within their industry. The survey's

groundwork was based on the eight most discussed elements of team success that originated from scholars over the past 50 years of research on the topic. The responses and analysis of the data from the survey provided some understanding of the topic.

Major Findings

Research Question 1

To what degree do nonmanagerial cross-functional project team members working in biotechnology perceive that the eight elements of teams are important for success?

The eight elements of teamwork were intermixed within 19 statements throughout the survey. The participants of the survey were asked to rate these statements on a 4-point Likert agreement scale. The statements were divided into four major categories:

1. Objectives
2. Roles
3. Organizational structure
4. Elements of working in a team

The four categories were derived as elements from the overall eight elements. The design of the survey was to ask questions based on the eight elements of a team's success. A Likert scale was used with response choices ranging from *strongly disagree* to *strongly agree*. Therefore, the researcher was looking for responses that were provided in the higher percentage range of *somewhat agree* to *strongly agree* on the scale in order to gain insight into participants' responses to items on the survey that they most

agreed with. The statements rated with this response type were those answers that gave additional insight into what the respondents felt were the elements necessary for team success. In addition, respondents to the survey were asked, when taking the survey, to answer the questions while thinking about a team that they currently or recently worked with. The first 19 questions of the survey touched on the eight elements.

Finding 1. Out of the 19 statements, three received the highest level of agreement with a mean score of over 3.20:

1. "I feel challenged in my role within my team."
2. "My team has goals that we work towards."
3. "Working in a science-based industry, I feel the need to have a science-based background to succeed."

Of the four major categories, two were represented in these responses: objectives and elements of working in a team. Fifty percent of respondents who took the survey rated these questions with the answers of *somewhat agree* and *strongly agree* from the Likert scale. These responses helped to lay the groundwork of the results for the researcher as to how the participants who took the survey functioned within their roles. The respondents had roles that they felt they were challenged in, and those roles offered them goals that they were working toward. It was important to participants who took this survey that those working within the biotechnology industry have a science-based background. This is in keeping with the current literature that speaks to the suggestion that in this industry, it is necessary to have a science-based background in order for individuals to work at their highest potential (Pisano, 2006a).

Finding 2. Out of the 19 statements, the statements on the survey that received the lowest rate of participant agreement had mean scores around 2.55:

1. "I am clear about the role of others on my team."
2. "The whole team contributes to the objectives."
3. "There is little to no overlap in roles on my team."
4. "I think my team received satisfactory training and information that pertains to our work in order for us to succeed."
5. "My team has the right people filling the necessary roles."

Of the four major categories, three were represented in these responses: objectives, organizational structure, and roles. These findings suggest that of those who took the survey, the teams in which they worked were generally well structured on the level of the roles and objectives of the teams' function. These findings also suggest that of the team elements presented to the participants in this survey, those related to the structure, training, and functions of those on a team were not deemed statistically significant in the results of this survey.

Research Question 2

What do nonmanagerial cross-functional project team members working in biotechnology perceive as the single most important element of the eight elements of teams that are most important for success?

The second half of the survey, which included Survey Question 20 and the three demographic questions, was designed to get feedback from those participating in the

survey. The 20th question on the survey directly asked participants to choose one single element from the eight elements that they believed was most important. The biotechnology industry is diverse with the employees that work within it (Lindgren & Packendorff, 2011). The backgrounds of those who work in this industry include different ethnicities, years of experience in the field, and gender. Therefore, this section of the survey helped to identify (of those willing to reveal this information) what the demographics were of those who participated in the survey.

Of the eight elements listed for participants to choose from, the element that was chosen by 19% of the respondents as the single most important element was "having a team that communicates as needed to discuss any issues that come up." Closely following with 16% of respondents choosing it was "having a clear purpose." The research on the topic of teams has shown that communication is needed for teams to be able to function on an optimal level. Harvey and Drolet (2004) touched on communication, stating, "We readily assume that most conflicts are perceptual, but they are not. Communication and feedback help misunderstandings" (p. 125). The importance placed on having a clear purpose is a finding that suggests that of those who responded to this survey, many do not feel that their teams currently have clear direction, since the respondents were asked when taking the survey to focus on a current or recent situation of working on a team.

Research Question 3

Is there a significant difference in perceived importance of team elements based on gender?

Gender and other demographic responses were obtained from the survey regarding the eight team elements only, not the four major categories of teams. When breaking down the responses between the genders (male and female), "having a team that communicates as needed to discuss issues that come up" was rated higher among female responders than among male responders. Female responders also provided a higher response rate for "having a clear purpose." Males responded higher to the elements of "knowing that my ideas are acknowledged" and "feeling that I am gaining personal development in my role as a team member." These results suggest that males and females in the industry of biotechnology individually have different perspectives on what elements of teams are most important.

Research Question 4

Is there a significant difference in perceived importance of team elements based on ethnicity?

The ethnic groups that responded to the survey were of African American, Asian, Caucasian, and Hispanic/Latino descent. If respondents did not identify with one of the ethnicities listed, they could choose "other" or choose not to respond to the question. Of those who chose to respond with their ethnicity, the results once again varied on the elements deemed most important based on ethnicity.

African Americans provided the same high response rate of 17.9% for "having the freedom to communicate" and "feeling that I am gaining personal development in my role as a team member." Caucasians' highest response rate of 25.3% was for the element of "having a team that communicates as needed to discuss any issues that come up." Asians' highest response of 20.0% was for "receiving feedback from leaders," and Hispanics/Latinos had a response rate of 33.3% for the element of "knowing that my ideas are acknowledged." With the varying level of response rates from participants, the results show that those with different ethnic backgrounds have opposing viewpoints as to the single most important element contributing to the success of a team.

Research Question 5

Is there a significant difference in perceived importance of team elements based on years of experience in the biotechnology industry?

The years of experience that participants of the survey had to choose from were less than 2 years, 2 to 5 years, and more than 5 years of experience within the biotechnology industry. Of those who responded with less than 2 years of experience, "receiving feedback from leaders" was selected as the single most important element of success of a team with 21.4%. With 2 to 5 years of experience, "feeling that I am gaining personal development in my role as a team member" was deemed most important by respondents with 14.5%. Of those who responded with more than 5 years of experience, "having a team that communicates as needed to discuss any issues that come up" had the highest response with 24.7%. These results suggest a distinct difference in the focus of

elements in a team that workers have, based on the number of years they have worked within the industry.

Surprises

An unexpected answer in the findings that received a high response rate was "my team has goals that we work towards." In the biotechnology industry, as in any industry, goals are important as they relate to the work one performs within the industry. Milestone goals are set in order to help get the product to the desired stage. However, there are cases where those goals often get lost in other work and are not followed as closely throughout the life of the study (Pisano, 2006a). The high response rate of *somewhat agree* and *strongly agree* regarding teams having goals that they work toward indicates that setting goals that are present and being followed was a high priority among the responders to this survey.

Conclusions

This study provides a first look into teams working together in the biotech industry to accomplish a goal. Gaining insight was the main goal in researching this topic due to the fact that this area is underresearched.

It is concluded that communication remains an important element for teams in biotechnology and needs to be present for teams to be successful. Goals were identified as an area of strong agreement among respondents as being utilized within their companies. Though goals can be helpful for teams, communication of the goals needs to take place so that they can be followed accordingly. Furthermore, communication in a

regulated environment, such as biotechnology, is vital to the success of the company to stay within the guidelines of the regulations (Zeller, 2002).

Additional studies and research need to be conducted to take a more in-depth look at other elements that teams need in order to be truly successful in navigating through this industry.

Implications for Action

Based on the data collected and background research conducted for this study, the following implications for action are suggested:

1. Managers must be mindful of how teams are designed and should consider demographics when placing individuals on teams. The survey results clearly show that there are varying views on team success based on demographics. If the team is diverse, knowing where members of the team stand on what is needed for the team to be successful could aim the team in the right direction.
2. Communication and giving clear guidance is a must, as is meeting regularly to make sure everyone is on the same page. Not only can communication help with guidance, it can also boost the morale of the employees in that they will feel more invested in the company if they are kept abreast of information that pertains to them and their roles.
3. Managers should hold mandatory project meetings with all responsible parties at the meeting. Meetings tend to start out strong and then drop off over time, so the communication that is needed is not shared among the team. If these meetings are

driven by upper management and everyone is held responsible, the communication would not lack among teams.

4. Respondents to the survey felt it important that those who work in the biotechnology industry have a background in science-based curriculum. Teams would benefit from goals that are focused and oriented in the science field. As was stated by Pisano (2006a), science business is not like ordinary business. Therefore, the focus for teams in this industry should have elements of science-based principles. Chief among them would be along the lines of working in a regulated environment. Regulations drive this industry; when they are not followed as intended, intellectual property could be at stake. These principles should be intertwined into the work that teams perform to keep the focus on industry practices.

Recommendations for Further Research

Based on the survey results and conclusions drawn from the research for this study, the following are recommendations for further research:

1. Obtain more responses from participants. Due to limited access to the population, obtaining more results was not feasible for this study. More responses would have given a more in-depth view of the circumstances. Because biotechnology companies tend to be large (more than 100 employees), surveying teams in one company at a time could give more insight directly into what elements employees feel are most important.

2. Go further with the research on the demographics. As has been stated, the biotechnology industry can be diverse in many ways as far as those who work within the companies. Individuals with different ethnic backgrounds have varying views on what is important to them with different working functions. Though this study looked only at teamwork, the possibilities are endless as to other major areas of ethnic groups working together that could be researched. Knowing what elements are deemed important to certain ethic groups could help facilitate better working environments, catered to a certain ethic group's preference. Once those elements are known, further research could be conducted as to how certain elements work together. Differing elements are not negative or positive in and of themselves. Knowing how to make them work together is key to successful and productive working relationships.
3. Conduct a case study of one particular company. This study was based on many companies in the Southern California area. However, it would be beneficial to gather results on a larger scale and apply them to one company that might be struggling with unproductive teams. A case study would allow for an individual focus on a team's issues.
4. Redesign this study with fewer elements. Though the elements were from a list that was scaled back from many elements of teams based on the literature, eight elements proved to be too many when comparing results.
5. Look at different types of companies within this industry. Not all biotech companies focus on the same indications. Some focus on indications of oncology, others on medical devices. To zone in on particular areas would help reach teams within those

particular areas that may work differently from teams within their industries that focus on their niche indication. Basically, this would help to give teams the best possible information on how to work best within their companies.

6. A look at what motivates employees who work in this industry could further help build strong teams. Biotechnology is a field that is unique to work within. Though unfortunate, in current times many individuals know of a family member or friend who has battled cancer or other grievous illnesses. For some, this could be a motivating factor to enter a field that researches medications that could help cure or prevent such illnesses. Whatever the reason, if there is motivation within an individual to enter this line of work that is of a personal nature, there could be other elements besides the eight researched in this study that could motivate one to do one's best in this work. Motivational factors could be the next direction to take this research of the elements of teams.

Concluding Remarks

The passion that I have for the topic of teamwork in the biotechnology industry is due to the fact that this is the industry in which I work. I see teams struggling with one another for different reasons, many of which were noted in this research, such as a lack of communication or lack of direction through a clear purpose. Though some might think this is just a typical issue faced by groups of people working together regardless of industry, what makes the situation unique for those in the biotechnology industry is that the focus is on the patient. Throughout my career in this industry, it has been said many

times that the focus of our work, no matter how great or how small, should always be on the patients. The patients are waiting—waiting for those of us who work in this industry to get drugs and devices to the market quickly and safely. There are many phases and regulations to accomplish this task, but it is undeniable that teams that function efficiently must be a part of this equation.

Though this research is just a small view of how teams can function better within the biotech industry, it is a first step in looking into an area that is currently sparsely studied. More research should be done to go more in depth into what teams in this industry feel could help them function best. Biotechnology companies have brought much aid to those in need for years. Patients are waiting—waiting for new innovations in medicine to stay on the forefront of the needs of those affected by various grievous illnesses. Working together is key. Working together as an effective team is the key to success, and in the case of biotechnology companies, success can enhance one's well-being and possibly save a life.

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APPENDICES

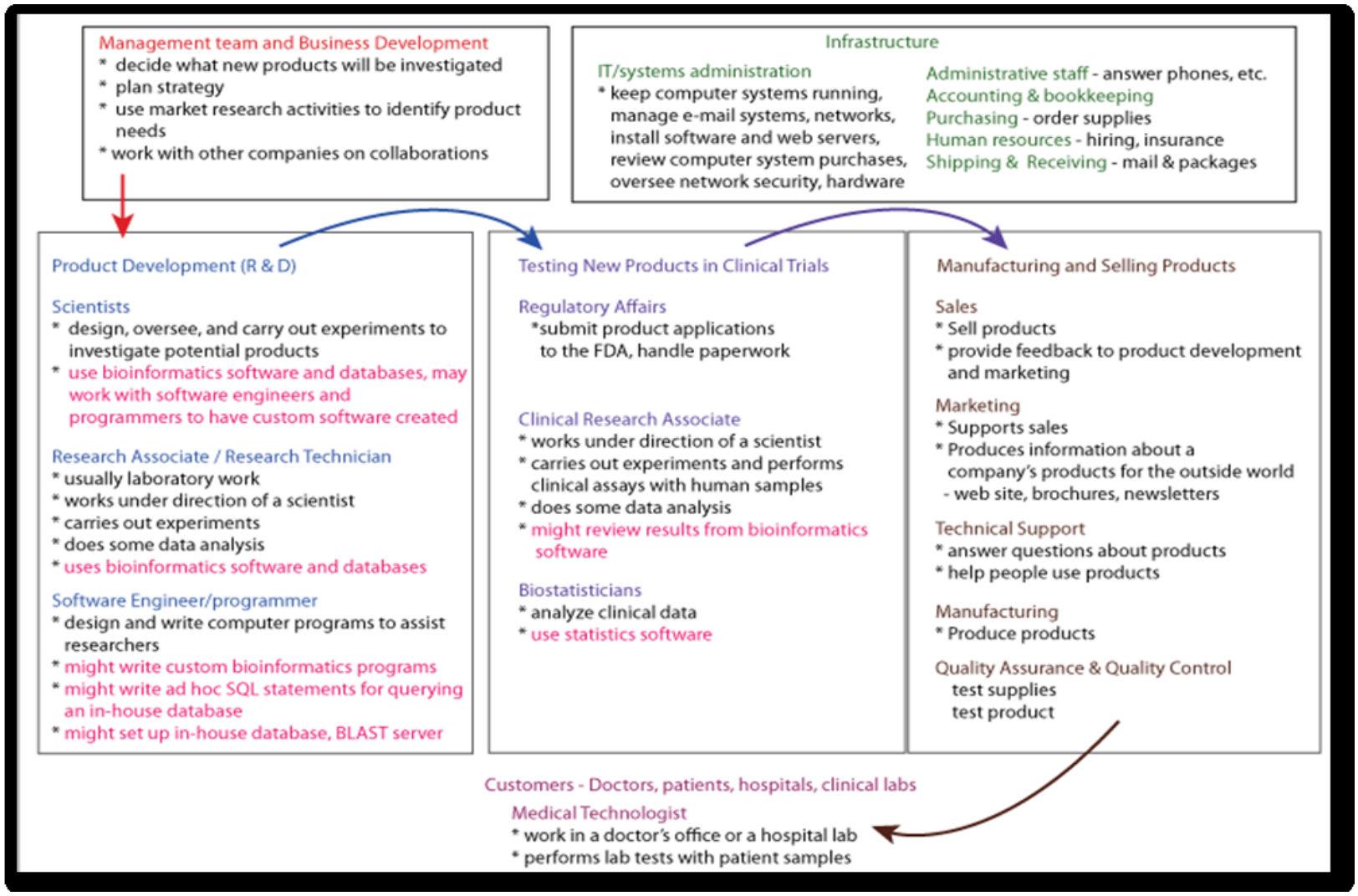
APPENDIX A

ELEMENTS OF TEAM EFFECTIVENESS MATRIX

1	Elements of an Effective Team	MacGregor 1960	Bernard Bass 1985	Shonk 1992	Dyer 1994	Robbins and Finley 2000	Ruth Wageman 2001	Goleman Boyatzis and Mckee 2002	Harvey and Drolet 2004	Richard Hackman 2005	Bolman and Deal 2008	Carl Robinson 2009	Pentland 2012
2													
3	Clear Purpose	X	X	X	X		X	X	X	X	X	X	X
4	Understanding of task at hand	X			X				X				
5	Performance goals are clear	X			X	X			X		X		X
6	Participation is high	X			X					X			
7	People are free to communicate (express their ideas)	X			X	X		X	X			X	X
8	When there are disagreements they handled productively	X							X				
9	Decisions are made with mutual agreement		X		X							X	
10	Each Individual carries their own weight in task	X						X			X		
11	Criticism is handled well	X							X				
12	Everyone is a leader from time to time	X			X					X			
13	Performance standards are high from leader expectations	X							X				X
14	Differences are acknowledged		X	X	X	X			X				
15	Healthy level of Stress					X			X		X		
16	Tolerant of errors		X					X	X				
17	Group maintenance is frequent								X				X
18	The group ask questions and listens	X			X			X	X		X		
19	Recognition of outside forces								X				
20	It is clear who is in change of the team and has the authority			X		X			X		X		X
21	The team forms organically at times					X			X	X	X		X
22	Confronting conflict head on					X			X				
23	Team members are interested in one another					X							
24	Feedback is provided from time to time		X		X	X			X				X
25	Celebration of accomplishments					X			X				
26	Challenging task goals that provide the team development		X			X	X		X	X		X	X
27	Task interdependence						X						
28	Support top team											X	
29	Emotional intelligence of the group							X					
30	More effective cost production when teams do the work			X									X

APPENDIX B

BIOTECHNOLOGY RESEARCH AND DEVELOPMENT STRUCTURE


Management team and Business Development
* decide what new products will be investigated
* plan strategy
* use market research activities to identify product needs
* work with other companies on collaborations
Infrastructure
IT/systems administration
* keep computer systems running, manage e-mail systems, networks, install software and web servers, review computer system purchases, oversee network security, hardware
Administrative staff - answer phones, etc.
Accounting & bookkeeping
Purchasing - order supplies
Human resources - hiring, insurance
Shipping & Receiving - mail & packages
Product Development (R & D)
Scientists
* design, oversee, and carry out experiments to investigate potential products
* use bioinformatics software and databases, may work with software engineers and programmers to have custom software created
Research Associate / Research Technician
* usually laboratory work
* works under direction of a scientist
* carries out experiments
* does some data analysis
* uses bioinformatics software and databases
Software Engineer/programmer
* design and write computer programs to assist researchers
* might write custom bioinformatics programs
* might write ad hoc SQL statements for querying an in-house database
* might set up in-house database, BLAST server
Testing New Products in Clinical Trials
Regulatory Affairs
*submit product applications to the FDA, handle paperwork
Clinical Research Associate
* works under direction of a scientist
* carries out experiments and performs clinical assays with human samples
* does some data analysis
* might review results from bioinformatics software
Biostatisticians
* analyze clinical data
* use statistics software
Manufacturing and Selling Products
Sales
* Sell products
* provide feedback to product development and marketing
Marketing
* Supports sales
* Produces information about a company's products for the outside world - web site, brochures, newsletters
Technical Support
* answer questions about products
* help people use products
Manufacturing
* Produce products
Quality Assurance & Quality Control
test supplies
test product
Customers - Doctors, patients, hospitals, clinical labs
Medical Technologist
* work in a doctor's office or a hospital lab
* performs lab tests with patient samples

APPENDIX C

LETTER TO MANAGERS

Dear _____,

My name is Robin Farmer and I am a doctoral candidate student from the University of La Verne examining The Elements of Teamwork That are Most Important in Biotechnology Jobs. I am at the point in my research were I need feedback from participants in this industry. How teams work in the biotech/pharma industry is currently very understudied. I would like your help in changing that by submitting my survey to members of your team that currently work in a team setting. The conclusions drawn from this study may provide better insight to individuals currently working in the biotechnology industry. Furthermore my hope as the researcher who currently works in this industry, is that the information gained from the results of the overall study may aid in better functioning teams in this industry.

If you have team members within your company who work in the Research and Development area of the organization and would be willing to take a short 7-10 minute survey please follow the steps below:

- Forward this email along with the attached email to participants from me
- Send link below along with attached email (the link has an attached Informed Consent that the participants can read prior to taking the survey)

Again, the sole purpose of this survey is for my doctoral research as current student. Participation from your team members is 100% voluntary and all information obtain from their responses is both confidential and anonymous to me as the researcher. Furthermore, no information about your company will be utilized as the selection process of companies contacted was done at random.

Again your help is greatly appreciated and any questions you have for me regarding this email or my research can be directed to my contact information below.

Thank you!

Robin Farmer
Robin.farmer@laverne.edu
714-643-9069

APPENDIX D

LETTER TO PARTICIPANTS

Dear Mr./Mrs./Dr.,

Thank you for your willingness to participate in my research study!

My name is Robin Farmer and I am a doctoral candidate examining The Elements of Teamwork That are Most Important in Biotechnology Jobs. Your participation by taking my survey will assist me in gathering data that will be used in the research section of my dissertation. How teams work in the biotech/pharma industry is currently very understudied. I would like your help in changing that by taking my survey. The conclusions drawn from this study may provide better insight to individuals currently working in the biotechnology industry. Furthermore my hope as the researcher who currently works in this industry is that the information gained from the results of the overall study may aid in better functioning teams in this industry.

The first step to obtaining results is by collecting data from my survey. Please complete the survey **(will only take 7-10 min of your time)** at your *earliest* convenience. Please answer all questions as incomplete surveys cannot be used.

Please know that your confidentially is of the utmost importance. Be assured, your responses will be kept confidential–no identifiable information will be shared or published. Furthermore, no responses given have any reflection on your biotechnology company. All data collected in connection with this research will be destroyed upon dissertation approval.

If you have any questions, please call me at 714-643-9069 or e-mail me at robin.farmer@laverne.edu.

Again, thank you for your participation, it is very much important and appreciated.

Sincerely,

Robin Farmer

APPENDIX E

INFORMED CONSENT

CONSENT TO PARTICIPATE IN RESEARCH

From Test Tube to Teamwork: The Elements of Teamwork that are Most Important in Biotechnology Jobs

You are being asked to participate in a research study conducted by *Robin Farmer,* a doctoral candidate from the Organizational Leadership and Development Ed.D program at the University of La Verne. You were selected as a possible participant (out of 300 total) in this study because you currently work or have worked in the biotechnology/pharmaceutical industry.

- **PURPOSE OF THE STUDY**

The first purpose of this study is to identify and describe to what degree non-managerial cross functional project team members working in the research and development sector of biotechnology perceive that the eight elements of teams' effectiveness are most important for success. The second purpose of the study is to identify the relationship between demographic characteristics of team membership and those elements perceived as most important.

- **PROCEDURES**

If you decide to participate in this study, I am asking that you complete an online survey which should take from 7-10 minutes.

- **POTENTIAL RISKS AND DISCOMFORTS**

The survey does ask demographic information such as gender and ethnicity; however you can choose to decline to answer these questions. However, please keep in mind that there will be 300 participants total in the survey so no individuals can be identified in any way.

- **POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY**

Participants will not receive any benefits from participating in this study.

How teams work in the biotechnology/pharmaceutical industry is an area sparsely studied. Any feedback from participants in this industry will add to the body of knowledge on the subject.

- **PAYMENT FOR PARTICIPATION**

There will be no payment for participation

- **CONFIDENTIALITY**

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. All aggregate data will be stored in a secured file for a minimum of three years and then permanently destroyed. If any content is published, it will only be done for scientific purposes. That is, data will be used to further the cause of science rather than for personal reasons.

- **PARTICIPATION AND WITHDRAWAL**

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you don't want to answer and still remain in the study.

- **IDENTIFICATION OF INVESTIGATORS**

If you have any questions or concerns about the research, please feel free to contact:

Robin Farmer – Doctoral Candidate
Robin.Farmer@laverne.edu
805-302-4415

Dr. Keith Larick (Dissertation Chair)
ktlarick@inreach.com

- **RIGHTS OF RESEARCH PARTICIPANTS**

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research participant, contact Marcia L. Godwin, Ph.D., IRB Director, at 909-593-3511, extension 4103, (mgodwin@laverne.edu). University of La Verne, Institutional Review Board, 1950 Third Street, CBPM 123, La Verne, CA 91750.

SIGNATURE OF RESEARCH PARTICIPANT OR LEGAL REPRESENTATIVE

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

_____
Printed Name of Participant

_____
Printed Name of Legal Representative (if applicable)

_____ _____
Signature of Participant or Legal Representative Date

SIGNATURE OF INVESTIGATOR (If required by the IRB)

In my judgment the participant is voluntarily and knowingly giving informed consent and possesses the legal capacity to give informed consent to participate in this research study.

_____ _____
Signature of Investigator Date

APPENDIX F

IRB APPROVAL

University of La Verne
Institutional Review Board

TO: Robin Farmer, Doctor of Education Program

FROM: University of La Verne, Institutional Review Board

RE: **2013-CEOL-34- From Test Tube to Teamwork: The Elements of Teamwork That are Most Important in Biotechnology Jobs**

The research project, cited above, was reviewed by the College of Education and Organizational IRB Committee. The college review determined that the research activity has minimal risk to human participants, and the application received an Expedited review. The application was approved with no additional conditions.

A copy of this approval letter is required to be included as an appendix to your completed dissertation. The project may proceed to completion, or until the **date of expiration of IRB approval, June 12, 2014.** Please note the following conditions applied to all IRB submissions:

No new participants may be enrolled beyond the expiration date without IRB approval of an extension.

The IRB expects to receive notification of the completion of this project, or a request for extension within two weeks of the approval expiration date, whichever date comes earlier.

The IRB expects to receive prompt notice of any proposed changes to the protocol, informed consent forms, or participant recruitment materials. No additional participants may be enrolled in the research without approval of the amended items.

The IRB expects to receive prompt notice of any adverse event involving human participants in this research.

There are no further conditions placed on this approval.

The IRB wishes to extend to you its best wishes for a successful research endeavor. If you have any questions, please do not hesitate to contact me.

Approval Signature	Marcia L. Godwin, Ph.D. IRB Director/Chair	June 12, 2013 Date

For the Protection of Human Participants in Research
mgodwin@laverne.edu
(909) 593-3511, ext. 4103

APPENDIX G

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The Biotechnology Centers Directors are:

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This is great thank you for your help and I will follow all guiedlines below.
Thanks again,
Robin Farmer

Sent from my Verizon Wireless 4G LTE Smartphone
Hi Tim,

This is great thank you for your help and I will follow all guiedlines below.
Thanks again,
Robin Farmer

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-----Original Message-----
From: Gary Pisano <gary.pisano@gmail.com>
To: Robin <tmmgrl2500@aol.com>
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That's no problem. I am fine with you using that exhibit. Since HBS Publishing owns the copyright you need to contact them for official permission. See their web site for info.
Good luck with your thesis.
Gary Pisano

Sent from my iPhone

On Apr 23, 2013, at 7:44 AM, Robin <tmmgrl2500@aol.com> wrote:

Hello Mr. Pisano,
My name is Robin Farmer and I am currently an ABD student at the University of La Verne in La Verne California.
I am currently writing my dissertation on Teamwork in the biotech industry. I have used your work in my dissertation and have found it very helpful.
I am writing in hopes of receiving your permission to use a graph from your book "Science Business The Promise, The Reality, and the Future of Biotech" . The graphic I am interested in using is on page 14 Figure 1-2 titled "Conceptual Framework".
Please let me know how I can go about receiving your permission to use this graph in my dissertation if it is allowed.
Thank you for your time.
Robin Farmer
tmmgrl2500@aol.com
805-302-4415

BioPharmGuy Letter

From Adam Wilson adam@biopharmguy.com hide details

To Robin tmmgrl2500@aol.com

Thu, May 30, 2013 12:26 pm

To Whom it May Concern,

In January 2013, Robin Farmer purchased an informational list of Southern California biotech, life science and medical device companies from BioPharmGuy.com. BioPharmGuy allows purchased lists to be used for any legal purpose, which includes academic work such as dissertations.

If you have any questions, please contact me directly at adam@biopharmguy.com

Adam Wilson
President
BioPharmGuy.com

APPENDIX H

SURVEY

Effective Teams in Biotechnology Industry Survey

Reason for Survey

Biotechnology companies produce medications and other substances that have the potential to cure, manage, and prevent illness in humans. With such powerful potential, biotechnology organizations are often perceived as well-organized environments. However, the functionality of team performance is an area sparsely studied in biotechnology. The purpose of this survey is to identify the elements that teams working in Research & Development (R&D) branches of biotechnology perceive as most important to be successful.

Informed Consent

I have read and understand the *Informed Consent to Participate in Research* and agree to answer the survey.

❒1 Yes - I Agree (Survey Continues)

❒2 No - I Decline (Program Automatically Terminates)

Objectives

Please rate the extent to which you agree or disagree with the following statements about *objectives*.

	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
1. I understand our team's objectives	❒4	❒3	❒2	❒1
2. Our objectives are in writing	❒4	❒3	❒2	❒1
3. Our objectives are measureable	❒4	❒3	❒2	❒1
4. The whole team contributes to the objectives	❒4	❒3	❒2	❒1
5. Our objectives are science-based	❒4	❒3	❒2	❒1
6. My team has goals that we work towards	❒4	❒3	❒2	❒1

Roles

Please rate the extent to which you agree or disagree with the following statements about *roles*.

	Strongly Agree	Agree Somewhat	Disagree Somewhat	Strongly Disagree
7. My team has the right people filling the necessary roles	❒4	❒3	❒2	❒1
8. I am clear about my role within the team	❒4	❒3	❒2	❒1
9. Everyone on my team is held accountable for performing tasks	❒4	❒3	❒2	❒1
10. I am clear about the role of others on my team	❒4	❒3	❒2	❒1
11. There is little to no overlap in roles on my team	❒4	❒3	❒2	❒1

Organizational Structure

Please rate the extent to which you agree or disagree with the following statements about *organizational structure*.

	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
12. Working in a science-based industry I feel the need to have a science-based background to succeed	❒4	❒3	❒2	❒1
13. Being focused on innovation is important in my role	❒4	❒3	❒2	❒1
14. I think my team received satisfactory training and information that pertains to our work in order for us to succeed	❒4	❒3	❒2	❒1
15. I feel the work processes we have in place are helpful so that I can fulfill my job	❒4	❒3	❒2	❒1

Elements of Working in a Team

Please rate the extent to which you agree or disagree with the following statements about *elements of working in a team*.

	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
16. I feel comfortable expressing my ideas in my team work environment	❒4	❒3	❒2	❒1
17. I feel challenged in my role within my team	❒4	❒3	❒2	❒1
18. I feel I receive proper feedback from my manager for the work I do within my team	❒4	❒3	❒2	❒1
19. My team meets to discuss action plans when needed	❒4	❒3	❒2	❒1

20. Which **single** element of those listed below do you personally feel is **most** important to the success of working in a team in the biotech/pharmaceutical industry?

❒1 Having a clear purpose
❒2 Having clear performance goals
❒3 Having the freedom to communicate
❒4 Knowing that my ideas are acknowledged
❒5 Having a team that asks questions
❒6 Having a team that communicates as needed to discuss any issues that come up
❒7 Receiving feedback from leaders of the team
❒8 Feeling that I am gaining personal development in my role as a team member

Demographics

1. What is your gender?

❒1 Male
❒2 Female
❒3 Decline to answer

2. What is your ethnicity?

❒1 African American
❒2 Asian
❒3 Caucasian
❒4 Hispanic/Latino
❒5 Other
❒6 Decline to answer

3. How long have you worked in the biotech/pharmaceutical industry?

   ❒1 Less than two years
   ❒2 Two to five years
   ❒3 More than five years

Thank you for taking the time to participate in this study. If you are interested in obtaining a copy of the final results or have questions about the research, you may contact Robin Farmer at robin.farmer@laverne.edu.

T H A N K Y O U!

APPENDIX I

SUMMATIONS FOR SURVEY QUESTIONS

Objectives

1. I understand our team's objectives

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2 Somewhat Disagree	36	19.7	19.7	19.7
	3 Somewhat Agree	78	42.6	42.6	62.3
	4 Strongly Agree	69	37.7	37.7	100.0
	Total	183	100.0	100.0	

2. Our objectives are in writing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	15	8.2	8.2	8.2
	2 Somewhat Disagree	42	23.0	23.1	31.3
	3 Somewhat Agree	73	39.9	40.1	71.4
	4 Strongly Agree	52	28.4	28.6	100.0
	Total	182	99.5	100.0	
Missing	System	1	.5		
Total		183	100.0		

3. Our objectives are measureable

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	21	11.5	11.5	11.5
	2 Somewhat Disagree	41	22.4	22.5	34.1
	3 Somewhat Agree	67	36.6	36.8	70.9
	4 Strongly Agree	53	29.0	29.1	100.0
	Total	182	99.5	100.0	
Missing	System	1	.5		
Total		183	100.0		

4. The whole team contributes to the objectives

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	32	17.5	17.5	17.5
	2 Somewhat Disagree	53	29.0	29.0	46.4
	3 Somewhat Agree	60	32.8	32.8	79.2
	4 Strongly Agree	38	20.8	20.8	100.0
	Total	183	100.0	100.0	

5. Our objectives are science-based

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	13	7.1	7.1	7.1
	2 Somewhat Disagree	49	26.8	26.8	33.9
	3 Somewhat Agree	79	43.2	43.2	77.0
	4 Strongly Agree	42	23.0	23.0	100.0
	Total	183	100.0	100.0	

6. My team has goals that we work towards

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	3	1.6	1.6	1.6
	2 Somewhat Disagree	26	14.2	14.3	15.9
	3 Somewhat Agree	81	44.3	44.5	60.4
	4 Strongly Agree	72	39.3	39.6	100.0
	Total	182	99.5	100.0	
Missing	System	1	.5		
Total		183	100.0		

Roles

7. My team has the right people filling the necessary roles

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	11	6.0	6.1	6.1
	2 Somewhat Disagree	46	25.1	25.4	31.5
	3 Somewhat Agree	100	54.6	55.2	86.7
	4 Strongly Agree	24	13.1	13.3	100.0
	Total	181	98.9	100.0	
Missing	System	2	1.1		
Total		183	100.0		

8. I am clear about my role within the team

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	10	5.5	5.6	5.6
	2 Somewhat Disagree	35	19.1	19.4	25.0
	3 Somewhat Agree	72	39.3	40.0	65.0
	4 Strongly Agree	63	34.4	35.0	100.0
	Total	180	98.4	100.0	
Missing	System	3	1.6		
Total		183	100.0		

9. Everyone on my team is held accountable for performing tasks

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	12	6.6	6.6	6.6
	2 Somewhat Disagree	61	33.3	33.7	40.3
	3 Somewhat Agree	58	31.7	32.0	72.4
	4 Strongly Agree	50	27.3	27.6	100.0
	Total	181	98.9	100.0	
Missing	System	2	1.1		
Total		183	100.0		

10. I am clear about the role of others on my team

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	35	19.1	19.6	19.6
	2 Somewhat Disagree	52	28.4	29.1	48.6
	3 Somewhat Agree	50	27.3	27.9	76.5
	4 Strongly Agree	42	23.0	23.5	100.0
	Total	179	97.8	100.0	
Missing	System	4	2.2		
Total		183	100.0		

11. There is little to no overlap in roles on my team

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	22	12.0	12.2	12.2
	2 Somewhat Disagree	56	30.6	31.1	43.3
	3 Somewhat Agree	76	41.5	42.2	85.6
	4 Strongly Agree	26	14.2	14.4	100.0
	Total	180	98.4	100.0	
Missing	System	3	1.6		
Total		183	100.0		

Organizational Structure

12. Working in a science-based industry I feel the need to have a science-based background to succeed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	6	3.3	3.4	3.4
	2 Somewhat Disagree	25	13.7	14.0	17.3
	3 Somewhat Agree	73	39.9	40.8	58.1
	4 Strongly Agree	75	41.0	41.9	100.0
	Total	179	97.8	100.0	
Missing	System	4	2.2		
Total		183	100.0		

13. Being focused on innovation is important in my role

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	4	2.2	2.2	2.2
	2 Somewhat Disagree	43	23.5	24.0	26.3
	3 Somewhat Agree	75	41.0	41.9	68.2
	4 Strongly Agree	57	31.1	31.8	100.0
	Total	179	97.8	100.0	
Missing	System	4	2.2		
Total		183	100.0		

14. I think my team received satisfactory training and information that pertains to our work in order for us to succeed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	24	13.1	13.3	13.3
	2 Somewhat Disagree	49	26.8	27.2	40.6
	3 Somewhat Agree	76	41.5	42.2	82.8
	4 Strongly Agree	31	16.9	17.2	100.0
	Total	180	98.4	100.0	
Missing	System	3	1.6		
Total		183	100.0		

15. I feel the work processes we have in place are helpful so that I can fulfill my job

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	10	5.5	5.6	5.6
	2 Somewhat Disagree	43	23.5	23.9	29.4
	3 Somewhat Agree	85	46.4	47.2	76.7
	4 Strongly Agree	42	23.0	23.3	100.0
	Total	180	98.4	100.0	
Missing	System	3	1.6		
Total		183	100.0		

Elements of Working in a Team

16. I feel comfortable expressing my ideas in my team work environment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	5	2.7	2.8	2.8
	2 Somewhat Disagree	25	13.7	13.9	16.7
	3 Somewhat Agree	91	49.7	50.6	67.2
	4 Strongly Agree	59	32.2	32.8	100.0
	Total	180	98.4	100.0	
Missing	System	3	1.6		
Total		183	100.0		

17. I feel challenged in my role within my team

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	6	3.3	3.4	3.4
	2 Somewhat Disagree	30	16.4	16.8	20.1
	3 Somewhat Agree	60	32.8	33.5	53.6
	4 Strongly Agree	83	45.4	46.4	100.0
	Total	179	97.8	100.0	
Missing	System	4	2.2		
Total		183	100.0		

18. I feel I receive proper feedback from my manager for the work I do within my team

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	14	7.7	7.8	7.8
	2 Somewhat Disagree	47	25.7	26.1	33.9
	3 Somewhat Agree	71	38.8	39.4	73.3
	4 Strongly Agree	48	26.2	26.7	100.0
	Total	180	98.4	100.0	
Missing	System	3	1.6		
Total		183	100.0		

19. My team meets to discuss action plans when needed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	6	3.3	3.3	3.3
	2 Somewhat Disagree	38	20.8	21.1	24.4
	3 Somewhat Agree	66	36.1	36.7	61.1
	4 Strongly Agree	70	38.3	38.9	100.0
	Total	180	98.4	100.0	
Missing	System	3	1.6		
Total		183	100.0		

20. Which single element of those listed below do you personally feel is most important to the success of working in a team in the biotech/pharmaceutical industry?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Having a clear purpose	28	15.3	15.6	15.6
	2 Having clear performance goals	24	13.1	13.3	28.9
	3 Having the freedom to communicate	25	13.7	13.9	42.8
	4 Knowing that my ideas are acknowledged	25	13.7	13.9	56.7
	5 Having a team that asks questions	10	5.5	5.6	62.2
	6 Having a team that communicates as needed to discuss any issues that come up	35	19.1	19.4	81.7
	7 Receiving feedback from leaders of the team	16	8.7	8.9	90.6
	8 Feeling that I am gaining personal development in my role as a team member	17	9.3	9.4	100.0
	Total	180	98.4	100.0	
Missing	System	3	1.6		
Total		183	100.0		

Demographics

D1. What is your gender?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Male	83	45.4	45.9	45.9
	2 Female	98	53.6	54.1	100.0
	Total	181	98.9	100.0	
Missing	System	2	1.1		
Total		183	100.0		

D2. What is your ethnicity?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 African American	28	15.3	15.5	15.5
	2 Asian	30	16.4	16.6	32.0
	3 Caucasian	92	50.3	50.8	82.9
	4 Hispanic/Latino	21	11.5	11.6	94.5
	5 Other	7	3.8	3.9	98.3
	6 Decline to answer	3	1.6	1.7	100.0
	Total	181	98.9	100.0	
Missing	System	2	1.1		
Total		183	100.0		

D3. How long have you worked in the biotech/pharmaceutical industry?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Less than two years	28	15.3	15.5	15.5
	2 Two to five years	55	30.1	30.4	45.9
	3 More than five years	98	53.6	54.1	100.0
	Total	181	98.9	100.0	
Missing	System	2	1.1		
Total		183	100.0		

Descriptive Statistics

	N	Mean	Std. Deviation
1. I understand our team's objectives	183	3.18	.738
2. Our objectives are in writing	182	2.89	.916
3. Our objectives are measureable	182	2.84	.978
4. The whole team contributes to the objectives	183	2.57	1.008
5. Our objectives are science-based	183	2.82	.868
6. My team has goals that we work towards	182	3.22	.748
7. My team has the right people filling the necessary roles	181	2.76	.758
8. I am clear about my role within the team	180	3.04	.877
9. Everyone on my team is held accountable for performing tasks	181	2.81	.920
10. I am clear about the role of others on my team	179	2.55	1.055
11. There is little to no overlap in roles on my team	180	2.59	.883
12. Working in a science-based industry I feel the need to have a science-based background to succeed	179	3.21	.807
13. Being focused on innovation is important in my role	179	3.03	.807
14. I think my team received satisfactory training and information that pertains to our work in order for us to succeed	180	2.63	.921
15. I feel the work processes we have in place are helpful so that I can fulfill my job	180	2.88	.827
16. I feel comfortable expressing my ideas in my team work environment	180	3.13	.750
17. I feel challenged in my role within my team	179	3.23	.847
18. I feel I receive proper feedback from my manager for the work I do within my team	180	2.85	.906
19. My team meets to discuss action plans when needed	180	3.11	.851
Valid N (list wise)	168		

Reliability

Scale: Objectives

Case Processing Summary

		N	%
Cases	Valid	180	98.4
	Excluded[a]	3	1.6
	Total	183	100.0

[a]Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.759	6

Item Statistics

	Mean	Std. Deviation	N
Q1 1. I understand our team's objectives	3.17	.739	180
Q2 2. Our objectives are in writing	2.89	.921	180
Q3 3. Our objectives are measureable	2.84	.981	180
Q4 4. The whole team contributes to the objectives	2.56	1.009	180
Q5 5. Our objectives are science-based	2.82	.868	180
Q6 6. My team has goals that we work towards	3.21	.747	180

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1 1. I understand our team's objectives	14.32	9.748	.536	.719
Q2 2. Our objectives are in writing	14.60	8.945	.540	.713
Q3 3. Our objectives are measureable	14.65	8.251	.630	.686
Q4 4. The whole team contributes to the objectives	14.93	8.414	.569	.705
Q5 5. Our objectives are science-based	14.67	9.763	.414	.746
Q6 6. My team has goals that we work towards	14.28	10.626	.324	.764

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
17.49	12.765	3.573	6

Reliability

Scale: Roles

Case Processing Summary

		N	%
Cases	Valid	177	96.7
	Excluded[a]	6	3.3
	Total	183	100.0

[a]Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.738	5

Item Statistics

	Mean	Std. Deviation	N
Q7 7. My team has the right people filling the necessary roles	2.75	.752	177
Q8 8. I am clear about my role within the team	3.03	.878	177
Q9 9. Everyone on my team is held accountable for performing tasks	2.80	.917	177
Q10 10. I am clear about the role of others on my team	2.55	1.049	177
Q11 11. There is little to no overlap in roles on my team	2.59	.888	177

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q7 7. My team has the right people filling the necessary roles	10.98	7.255	.520	.690
Q8 8. I am clear about my role within the team	10.69	6.906	.487	.697
Q9 9. Everyone on my team is held accountable for performing tasks	10.93	6.682	.507	.690
Q10 10. I am clear about the role of others on my team	11.18	5.861	.583	.658
Q11 11. There is little to no overlap in roles on my team	11.14	7.141	.421	.721

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
13.73	9.926	3.151	5

Reliability

Scale: Organizational Structure

Case Processing Summary

		N	%
Cases	Valid	177	96.7
	Excluded[a]	6	3.3
	Total	183	100.0

[a]Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.448	4

Item Statistics

	Mean	Std. Deviation	N
Q12 12. Working in a science-based industry I feel the need to have a science-based background to succeed	3.21	.811	177
Q13 13. Being focused on innovation is important in my role	3.02	.804	177
Q14 14. I think my team received satisfactory training and information that pertains to our work in order for us to succeed	2.64	.913	177
Q15 15. I feel the work processes we have in place are helpful so that I can fulfill my job	2.89	.829	177

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q12 12. Working in a science-based industry I feel the need to have a science-based background to succeed	8.55	3.374	.076	.536
Q13 13. Being focused on innovation is important in my role	8.75	2.782	.309	.324
Q14 14. I think my team received satisfactory training and information that pertains to our work in order for us to succeed	9.13	2.330	.393	.217
Q15 15. I feel the work processes we have in place are helpful so that I can fulfill my job	8.88	2.859	.254	.378

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
11.77	4.259	2.064	4

Reliability

Scale: Elements of Working in a Team

Case Processing Summary

		N	%
Cases	Valid	178	97.3
	Excluded[a]	5	2.7
	Total	183	100.0

[a]Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.631	4

Item Statistics

	Mean	Std. Deviation	N
Q16 16. I feel comfortable expressing my ideas in my team work environment	3.15	.737	178
Q17 17. I feel challenged in my role within my team	3.22	.847	178
Q18 18. I feel I receive proper feedback from my manager for the work I do within my team	2.85	.905	178
Q19 19. My team meets to discuss action plans when needed	3.12	.841	178

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q16 16. I feel comfortable expressing my ideas in my team work environment	9.20	3.436	.479	.520
Q17 17. I feel challenged in my role within my team	9.12	3.777	.241	.678
Q18 18. I feel I receive proper feedback from my manager for the work I do within my team	9.49	2.850	.530	.464
Q19 19. My team meets to discuss action plans when needed	9.22	3.302	.418	.555

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
12.34	5.289	2.300	4