

Collaboration & Team Science:

A Field Guide

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Although from different backgrounds, areas of expertise, and perspectives, Michelle Bennett and Howard Gadlin came together with the goal of understanding what makes collaborative research teams succeed. They first began discussing the dimensions of scientific collaboration in 2004 when they were invited to co-present a session on collaboration and team science. Michelle had been working to promote collaborations and teams designed to research complex scientific problems. Howard had been involved in helping scientific collaborators and teams resolve internal conflicts and address problems in collective functioning. While preparing for their presentation, they realized that they were thinking about overlapping matters from very different perspectives and began to meet regularly. In the summer of 2007, Samantha Levine-Finley joined Michelle and Howard, and the trio embarked on a project to better understand the characteristics of scientific teams at NIH that have met with varying levels of success.

A Note From the Authors:

To discover a set of best practices for collaborations among scientists and researchers, we set out to:

- Understand the characteristics, processes, and dynamics that contribute to a team's success (or demise).
- Engage the biomedical research community to learn more about how team science should be initiated, conducted, and evaluated.
- Develop strategies to prevent, reduce, or mitigate conflict among researchers engaged in team science.
- Provide tools for individuals considering or planning to engage in team science.

As a first step, we reviewed a wide range of relevant literature on topics such as team building, interpersonal and group dynamics, conflict resolution, and the functioning of scientific teams and labs. Next, we generated our own data on scientific collaboration. We developed a semi-structured interview protocol containing 25 questions to ask team members, identified 5 self-assembled teams performing research at NIH, and secured the participation of 30 individual team members who represented a cross-section of disciplines, team roles, and career levels. After Samantha interviewed each participant in person and took detailed notes, we worked together to identify primary themes and concepts from the interviews and compared these findings with our literature review and existing models for successful team functioning. Howard and Michelle presented the preliminary results from this project at NIH Grand Rounds in August 2009 (see *References and Additional Resources* on page 67). Since that point, we have collaborated to turn our findings into this *Field Guide*.

It is our hope that this *Field Guide* will help researchers build or participate on research teams either on their own initiative or at the request of someone in their organization. Although the design and use of funding mechanisms to promote team science are important, these topics are beyond the scope of this *Field Guide*.

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Starting to Think About Team Science

Over the last decade, there has been a surge of interest and investment in multi- and interdisciplinary team science programs from public agencies and private organizations alike. Today it is widely accepted that “collaborations become necessary whenever researchers wish to take their research programs in new directions” (Macrina, 1995). As a result, innovations and advances that were not possible within one laboratory working in isolation are now emerging from collaborations and research teams that have harnessed techniques, approaches, and perspectives from multiple scientific disciplines and therapeutic areas. Team science has been described as a collaborative and often cross-disciplinary approach to scientific inquiry that draws researchers who otherwise work independently or as co-investigators on smaller-scale projects into collaborative centers and groups.*

As modern research methods have become more specialized and the true complexity of today’s most pressing health issues and diseases is revealed, collaborations among scientists trained in different fields have become essential for exploring and tackling these problems. This specialization of research methods has made interdependence, joint ownership, and collective responsibility between and among scientists near requirements. These features of team science may not suit everyone, but given these current trends, it is increasingly likely that most researchers will find themselves asked to participate on or lead a research team at some point in their careers.

First Collaboration

It can be extremely helpful to frame one’s first projects, both in graduate school and perhaps as a postdoctoral fellow, as collaborations. The collaborator in these instances is the investigator who hired the trainee to support his/her research program. If this relationship is treated as one between peers, based on trust and mutual respect, it will result in an outstanding training environment where the trainee will begin to progressively take on responsibility, contribute to the research agenda, and accept more accountability for experimental successes—and failures.

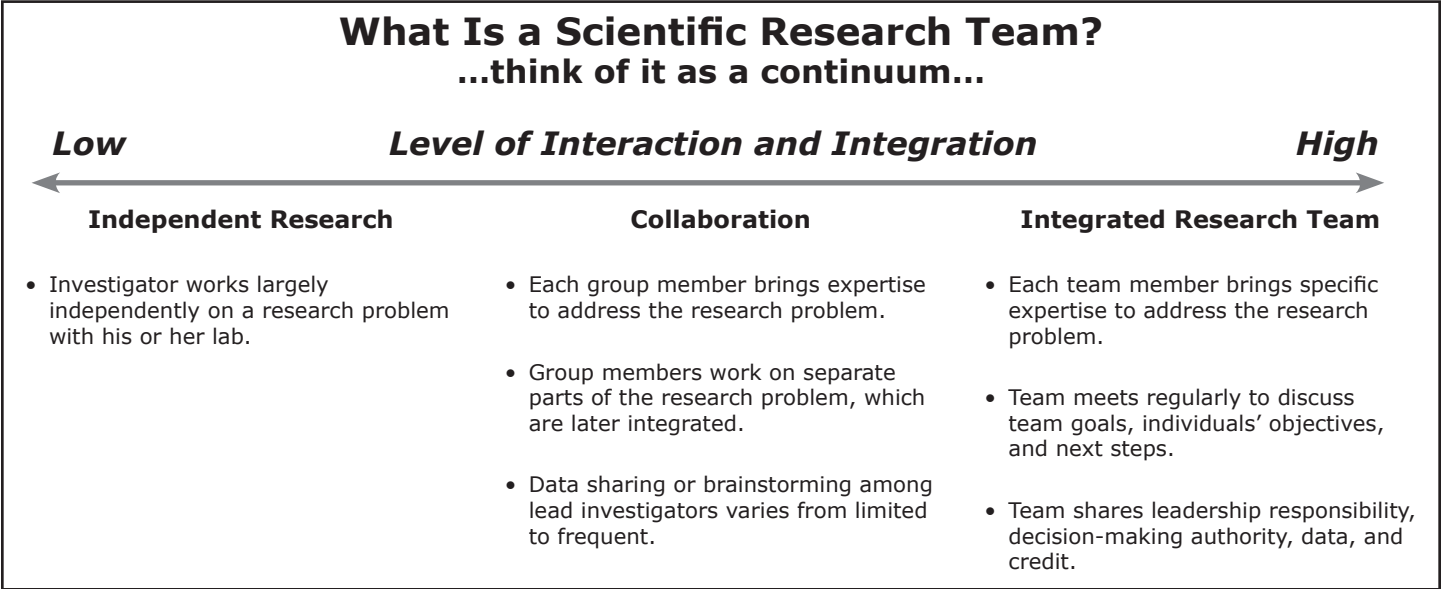
There are many types of research teams, each one as dynamic as its team members. Research teams may comprise investigators from the same or different fields. Research teams also vary by size, organizational complexity, and geographic scope, ranging from as few as two individuals working together to a vast network of interdependent researchers across many institutions. Research teams have diverse goals

spanning scientific discovery, training, clinical translation, public health, and health policy (Stokols, Hall, Taylor, Moser, & Syme, 2008).

This *Field Guide* was developed to help researchers navigate some of the rocky and murky territory associated with building a team either on their own or at the request of someone in their organization. It is not focused on team science from a granting agency or institutional perspective, which can include using funding mechanisms to catalyze and coordinate large-scale research efforts or team science.

As the figure on page 2 illustrates, research teams vary across a continuum of interaction and integration. This continuum provides a basic framework for understanding how this *Field Guild* conceptualizes teams. On one end of the spectrum is independent research, wherein a scientist works individually and independently on his or her research. Collaboration

* There is a field of inquiry called team science, or the science-of-team-science. This field encompasses an amalgam of conceptual and methodological strategies aimed at understanding and enhancing the outcomes of large-scale collaborative research and training programs. The field has emerged in recent years, largely in response to concerns about the cost-effectiveness of public- and private-sector investments in team-based science. Still, the boundaries and concerns of this field are difficult to discern and there is need for more data on team science’s major theoretical, methodological, and translational underpinnings (Stokols, Hall, Taylor, Moser, & Syme, 2008).



describes a scenario in which researchers work relatively independently on different aspects of a common scientific problem with at least some interaction. At the far right of the spectrum are integrated research teams—interdisciplinary groups that meet regularly (high interaction) and share leadership responsibility, data, and decision-making authority, as well as credit (high integration). This *Field Guide* addresses a wide range of team science, from collaborations to highly integrated research teams.

Of course, scientific teams also vary in terms of their duration. Some teams are put together for a very focused purpose and are not intended to have a life that extends beyond the accomplishment of a specific task. Others may be designed with the expectation of a long-term collaboration exploring multiple facets of a set of problems not expected to be resolved even over a fairly lengthy time frame.

As the focus on research teams sharpens, questions are emerging about what constitutes a successful team and how research teams can maximize their effectiveness and experiences. Not every team is successful—some are able to achieve only some of their goals, or fail and dissolve. Other teams are highly successful—reaching and often exceeding their recognized goals and creating positive experiences for team members and the institutions that support them. Why is this the case? What constitutes a

NIH Commitment to Team Science

2003	NIH's Bioengineering Consortium (BECON) hosts "Catalyzing Team Science" symposium
	NIH Roadmap includes "Research Teams of the Future" as a focus area
2006	NIH Tenure Review Committee revises criteria to include "team science"
	Clinical and Translational Science Awards (CTSA) Consortium is established to support and promote interdisciplinary teams
2006-2007	<i>NIH Guide for Intramural Research</i> is revised to include a more robust description of collaborative teams
2007	NIH institutes a multiple-PI grant mechanism

Note to the Reader:

Just as every research team is unique, so too may be your approach to the **Field Guide**. You may read it in the order in which it is written, or you may prefer to start with a topic that is most relevant to you at the current moment. Each module is devised to stand alone but also contains references to other modules because, not surprisingly, there are important connections among concepts. In addition, we have included a list of resources on various topics that we have found to be helpful at the end of the **Field Guide**.

successful research team? Why do some research teams succeed while others do not? What factors maximize a research team's productivity or effectiveness? How can research teams best be recognized, evaluated, and rewarded? *Collaboration and Team Science: A Field Guide* was developed to help answer these and other questions.

A host of factors determine whether a team will meet the challenges it faces or find itself struggling. These factors include characteristics such as team size, organizational complexity, geographic dispersal, leadership structure, level of formality or informality, relational dynamics, and context of establishment. To make matters more vexing, there are examples of successful and less successful groups for every combination of characteristics.

The *Field Guide* is intended for anyone who is currently participating on or leading a research team, considering becoming involved in a

research team, or contemplating building a research team. The first section—*Preparing Yourself for Team Science*—emphasizes how important it is that individuals at all levels reflect on how prepared and willing they are to engage in team science. The subsequent modules explore the many dynamic factors that contribute to successful research teams, offer suggestions on how to apply “best practices” to maximize research team effectiveness, and offer strategies to address the challenges and prevent or reduce the pitfalls that commonly confound or stymie research teams.

Notes

Preparing Yourself for Team Science

Team science is rapidly becoming a primary mode of operation for biomedical scientists and clinicians working on fascinating and complex questions involving human health. But making the most of the opportunities that team science has to offer may seem fraught with the challenges of adapting from a solo-investigator culture to one of collaboration. For example, individuals, collaborators, and highly integrated teams often have different perceptions and experiences of what this “team science” stuff is all about. Some people naturally function as part of a research team, while others must develop and apply skills to enable them to successfully contribute to team efforts. Effective team members and team leaders possess a number of skills that contribute positively to the overall functioning and success of the team. They must be able to communicate with others and both give and receive constructive feedback. In addition, they must also embrace a collaborative spirit, meaning they are willing to share data, credit, and decisionmaking with other team members. The strength of these skills is often dependent on an individual’s level of personal insight and self-awareness, ability to be in touch with his or her thoughts and feelings, and level of consciousness of his or her impact on other people. Whether you are participating on a research team or leading a research team, mentally and emotionally preparing yourself is critical to your team’s overall success. Some tips include:

- Recognize that others do not necessarily share your understandings or perceptions.
- Consider many options and possibilities for how others may understand or perceive an experience.
- Appreciate that different understandings and perceptions of experiences do not have to threaten your identity or relationships.

The scenarios below were developed to help stimulate thoughts around these challenges and to formulate questions so you can make the most of the opportunities team science presents.

Ask Yourself: Am I Ready to Participate on a Research Team?

- ✦ Can I thrive as a member of a highly collaborative research team? To what extent? What would it take?
- ✦ What would I gain? Do I have anything to lose?
- ✦ Am I willing to share data and credit with team members?
- ✦ Am I willing to accept constructive feedback and training from team members?
- ✦ Am I willing to provide constructive feedback and training to team members?
- ✦ Can I openly discuss issues and concerns with team members?

Case Study 1

It’s lunchtime and Dr. Welstrom is walking to the cafeteria with a colleague from another lab, Dr. Miller. Dr. Miller starts discussing a problem he is having with a specific team research project. He says he feels stuck; he has most of the expertise he needs but lacks it in one particular area that would allow him to truly advance his research. Dr. Welstrom tells him that she not only has the expertise and resources to help, but that she sees another line of inquiry that could be important to follow. Her contributions would help with the publication Dr. Miller is trying to prepare and also broaden its scope and contribute globally to the research project. Dr. Welstrom invites him to provide her with the cell lines she would need to

perform the experiments and says she'll provide him with any findings. Dr. Miller says that is not how his lab does things. Instead, he wants to introduce Dr. Welstrom to the team leader to discuss these ideas. As it turns out, the PI in Dr. Miller's lab is always open to new skills and perspectives of other scientists that will help them get the data needed. The lab finds it more rewarding to build a dynamic team that works together to uncover the multiple facets that underlie complex scientific questions, rather than have people work in isolation and just contribute data. As Dr. Welstrom enters the cafeteria and approaches the colorful salad bar, where she sees all the different vegetables that will soon combine to become her lunch, she realizes that she has the opportunity to become part of an interdisciplinary team. What does she need to know about being part of an interdisciplinary team?

Case Study 2

Dr. Antonelli has been running her own lab for a few years and things are going fairly well. She has had a couple of papers in high-impact journals and is feeling good about the contributions her group is making to science. Yet she knows her group could be doing much more with current projects. In fact, she has been formulating an idea for a much larger effort that would require her to bring together a number of experts in different fields. But Dr. Antonelli is hesitant to try to pull the trigger on starting that because she feels something is missing in her own lab. And she just can't put her finger on the problem. Dr. Antonelli has noticed that people in her lab don't offer much during weekly lab meetings and, when they do, they are reluctant to give details about their experiments. Sometimes they even make disrespectful comments to each other. She has been surprised when junior scientists have come to her with requests to work on projects that are irrelevant to the lab's mission. Most concerning, Dr. Antonelli finds herself having to stamp out often bitter arguments between some lab members over authorship and reliability of data. Where are things going wrong, and what can Dr. Antonelli do about it? And if she does do something about it, can she apply what she has learned to that bigger, bolder project that is bubbling in her mind?

Leadership

The characteristics of successful research team leaders are as diverse as the teams they lead. There is no one formula that can be applied to a successful leader. However, there are a number of common strengths exemplified by leaders that contribute to the overall success of the team. A team leader must be able to clearly and decisively communicate, share information with team members, and articulate the team's vision. He or she must be prepared to model a collaborative approach to science and motivate other members to do so as well. A team leader must also support and empower team members, assign roles and delegate responsibilities, and manage team members' expectations. Strong leadership

Ask Yourself: Am I Ready to Lead a Research Team?

- ✦ Am I able to clearly and decisively communicate and share information with team members?
- ✦ Am I prepared to clearly articulate my vision to team members?
- ✦ Am I prepared to model a collaborative process and inspire team members to achieve our shared goal?
- ✦ Am I willing to support team members at all levels and assign roles and responsibilities?
- ✦ Am I willing to manage team members' expectations?
- ✦ Am I prepared to select team members who will thrive in the team's culture?

Situational Leadership

The Situational Leadership Model developed by Hersey and Blanchard considers two factors:

- ✦ Maturity, or evolution, of the individual or team from dependence to independence
- ✦ Extension of the role of the leader from a “telling” style that focuses little on relationship and emphasizes providing lists of tasks to a “delegating” style in which the responsibility of how to do the work is given to the individual/team and the leader stays involved by monitoring.

In this model, the leader works purposefully with individuals or teams to help them mature in their roles in and responsibilities for the efforts at hand. The relationship progresses from one in which the primary role of the leader is to train and direct the work, to the next level where the individual/team gains knowledge and ability and the leadership effort shifts to providing direction with more dialogue and interaction. From there the relationship grows to one of shared decisionmaking with the leader needing to be less involved in directing the project and the individual/team gaining more confidence to work more independently. The last stage is characterized by a willingness and ability of the individual/team to work independently and the leader being willing to let the individual/team carry on the work in that manner. The relationship has developed trust and there is mutual respect between the leader and the individual/team.

(Hersey, Blanchard, & Johnson, 2007.)

that capitalizes on a portfolio of strengths is a critical component of team success.

Bringing together a talented group of researchers to work cooperatively to solve a problem takes time, commitment, passion, and a lot of hard work. Whereas everyone on the team plays an important role, there is typically one individual steering the effort. The leader can bring people together to brainstorm, discuss new ideas, develop strategies and time lines, and coordinate small contributions of individual resources that together can get a project off the ground. Leaders can build both personal and scientific trust among the team members and provide a conduit to senior leadership in the organization. In addition, they can foster mutual respect among the members, the desire to share data and credit, a willingness to continually challenge each other to advance the project while containing conflict, and the development of a dynamic process that evolves its priorities and vision over time.

Leadership styles, like leadership characteristics, vary widely. Some leaders employ a style in which they both

self-identify as the team leader and are seen clearly by others as heading the effort. They are in command and in charge. On the other hand, some would be less inclined to describe themselves as leaders and could be thought of as driving from the back of the bus. That is a leadership role that is less directive.

Once again, there is no right way. However, there are styles that can damage and derail a team effort, including:

- Absentee leadership—unavailable or insufficiently involved
- Inhibited leadership—conflict avoidant or averse and reluctant to handle difficult people or situations
- Defensive leadership—resistant to feedback regarding systemic problems and projecting outward blame
- Hostile leadership—actively promoting competition and conflict within the lab.

Strong scientific and interpersonal communication skills are critical and required to keep the group interacting, cohesive, and on course. Communication includes both the subjects for discussion as well as the logistical strategies for effective interactions. The leader must ensure that the team outlines roles and responsibilities, commitment of resources, and how credit for participation in team efforts will be shared and assigned. Communication strategies may include listservs, teleconferencing, interactive Web-based collaboration tools, and e-mail. Workshops and retreats provide forums for face-to-face interaction as well as strengthening and broadening of networks. The importance of learning each other's scientific languages cannot be understated.

The Value of a Mentor

Mentoring is an indispensable aspect of successful collaboration. When embarking on a collaborative effort for the first time, or as your collaboration evolves into a highly integrated and diverse team, being or having a good mentor can help. The absence of mentors can lead to frustration, uninformed decisionmaking, and poorly conceived behaviors on the part of more junior scientists that can undermine a research project.*

Being a Mentor

Leading a successful research team is much more than just being an effective supervisor or manager. While managers are talented at making expectations clear, holding people accountable, and dealing with conflict, good leaders are also able to articulate a vision and bring together people who are committed to attaining that vision. Gifted leaders are also skilled mentors who recognize the strengths of each team member and identify areas in which newer scientists have the greatest potential to grow.

Mentors are committed to helping others learn the nuances of the science, unravel and handle the politics of the organization and/or the discipline, develop scientific and other skills in various areas, and create strategies for successful collaborative interactions. Great mentors will help you achieve success along your chosen career path through assisting with networking, identifying opportunities, and tackling complex scientific situations or questions by assembling the right resources and sharing the formative successes and failures they faced along the way. Great mentors will support scientific collaborations by serving as thoughtful and encouraging guides for anyone involved in the endeavor.

Seeking a Mentor

It is valuable to have a mentor or several mentors—regardless of your career stage—who can serve as a sounding board as you work your way through the maze of issues, challenges, and opportunities you will face. If you do not have a mentor, consider seeking out and identifying an individual who could be a strong one for you. Although your supervisor may or may not be a mentor to you, he or she can be a terrific resource for identifying others who can help guide you in that role.

* For more on mentoring, take a look at *Entering Mentoring* by Handelsman, Pfund, Laufer, & Pribbenow (2005).

Are You Ready?

The Value of Self-Reflection

Whether you are a member or a leader, your contributions to your research team can benefit from self-reflection. Although you may not think that the consideration of the finer points of interpersonal dynamics is relevant to biomedical research, there is more of a connection between scientific thinking and self-reflection than appears at first glance. Both depend heavily on inferential reasoning—selectively focusing on observable data, drawing inferences about what the data might mean, and finding ways to test those inferences with additional observable data. While the “data” of interpersonal relationships may not have the facticity of data in research studies, they are nonetheless available for observation, inference, and reflection.

Over the years, studies of interpersonal dynamics, group functioning, and individual cognitive and emotional processes have established that, through self-reflection and communication, people can become more aware of themselves, their behavior, and the impact they have on others. More importantly, such awareness can give people greater control over their own reactions to others and improve the quality and direction of their relationships.

For this reason, self-awareness among team members is crucial for the effective and satisfying functioning of research teams. As written by Cohen and Cohen in *Lab Dynamics* (2005), an excellent discussion of management skills for scientists, “... self-awareness allows you to exercise behavioral options and choose the behavior that will be most effective, rather than the one that may make you feel good for the moment, but that you will later regret.”

However, to move toward self-awareness, it is necessary to overcome what social psychologist Lee Ross (Ross & Ward, 1996) has described as “naïve realism”—the belief that we see events as they really are. Each person believes that his or her attitudes and beliefs derive from an objective reaction to information and that other rational people will react in the same way if they are open to the same information. In this regard, scientists are like most other people.

Case Study 3

Two colleagues, Dr. Maxim and Dr. Lao, have just presented their research results at a conference. A question from the audience challenges the pair’s conclusions. Dr. Maxim responds defensively because he “heard” and “experienced” the challenge as an attack. Dr. Lao jumps into the discussion with a very different attitude; she welcomes the challenge and is eager to debate the data that led to the conclusion. These two people are asked the same question about the same data, yet each brings a very different perspective. Instantly, each person in the room, including Dr. Maxim and Dr. Lao, draws conclusions and creates “stories” to explain the researchers’ different reactions. It is likely that none is totally correct.

The following sections provide tools and resources that can help you explore and become more aware of how you see yourself and the world, which will provide useful insights into your contribution to the team dynamic.

Understanding Personality Types

There are myriad ways to describe differences in psychological functioning. Among the most well-known approaches to describing differences in the ways people think and feel is the Myers-Briggs Type Indicator (MBTI), a questionnaire derived from the psychological theories of C. G. Jung. This psychometric test assesses people in terms of their preferred stance toward others—extroverted versus introverted—and their preferred modes of psychological functioning—judging versus perceiving, thinking versus feeling, and sensing versus intuition (see sidebar).

The MBTI is commonly used to assess an individual's personality type by measuring his or her attitude, functioning, and lifestyle. It can help you understand your own way of thinking and feeling and can also help you appreciate personality differences that exist among other people.

For example, becoming aware of something as “obvious” as the difference between extroversion and introversion can help you work with, adapt to, and accept—rather than react against—someone whose attitude is different from your own. You will likely find that people with different styles can complement each other and offer strengths where others are less confident.

The MBTI is just one tool for beginning to think about personality types. It is also useful to simply reflect on how you see yourself and how you think others see you. For example, you might ask, “How collaborative am I?” and “How collaborative do others think I am?” Other questions you might ask can focus on your style of interacting with others: “How argumentative am I?” and “How argumentative do others think I am?” Cohen and Cohen (2005) provide excellent examples of questions for self-reflection and tools that allow you to rate your style of interaction as well as how you think others perceive you.

Recognizing the Impact of Your Emotions

Like most scientists, you probably think of yourself as objective, data-driven, and rational. While this may describe your approach to science, it is important to recognize that you also have emotional responses to the people and situations you encounter as you conduct your research (e.g., a failed experiment or an unexpected

Myers-Briggs Personality Types

Attitude

- ✦ Do you prefer to focus on the outer world of people and things (extraversion [E]) or on your own inner world of ideas and images (introversion [I])?

Functioning

- ✦ Do you prefer to focus on the information you receive through your five senses (sensing [S]) or do you prefer to interpret and add meaning to the patterns and possibilities you see (intuition [N])?
- ✦ When making decisions, do you prefer to first consider objective logic and facts (thinking [T]) or do you prefer to consider people and feelings involved (feeling [F])?

Lifestyle

- ✦ In dealing with the outside world, do you prefer structure and boundaries (judging [J]) or do you prefer openness and adaptability (perceiving [P])?

There are 16 Myers-Briggs personality types that result from combinations of preferences in these areas. So, for example, someone who prefers to focus on the outer world, receive information through his/her five senses, make decisions based on logic and facts, and be in settings characterized by structure and boundaries has personality type ESTJ.

The MBTI conceptualizes personality type as similar to left- or right-handedness: individuals are either born with or develop certain preferred ways of thinking and acting. No one type is better or worse; however, individuals naturally prefer one overall combination of type differences.

To take the MBTI or to learn more, visit <http://www.myersbriggs.org>.

result). Many scientists are not in touch with the depth and strength of their emotional reactions, which have implications for team science. Emotions can influence the way you interact with others and how you make decisions, both of which influence how well a research team functions.

“Emotional intelligence” is the subject of many books, articles, and presentations that highlight the notion that characteristics such as self-awareness, the ability to build healthy personal relationships, and understanding of the impact of emotions (our own as well as those of the people with whom we interact) are extremely important to effective leadership. In addition, this concept also addresses the ability to be aware of the greater context in which you and others operate. This recognition may facilitate communication, conflict management, and the skill to motivate others. Psychologist Daniel Goleman (1998) has suggested that emotional intelligence among leaders might be more important than how smart they are otherwise. He also suggests that, with practice, emotional intelligence can be learned.

Resolving Conflict

One arena in which it is especially useful to be aware of your emotions and reactions is in the way you handle and respond to disagreements or other types of conflict. A well-known

inventory of conflict styles, the Thomas-Kilmann Conflict Mode Instrument (Thomas & Kilmann, 1974), which was first published in 1974 with updates in 2002 and 2007, may help you identify your most natural style of resolving conflict as well as other conflict resolution styles that may be useful in different situations.

It is important to keep in mind that there are circumstances in which one particular conflict resolution style may be more effective; there are also circumstances where that same style can be a liability. For example, imagine the head of a research lab whose preferred mode of handling conflict is avoidance, which is quite common among scientists. If there is conflict among

the scientists in his lab and he is reluctant to address it, the conflict can fester, undermining the research endeavor and possibly derailing the project. Recognizing your conflict style preference and understanding the ramifications of the other styles can be helpful in guiding the way you approach future conflicts.

The most successful team players and leaders are those who are not held captive to their dominant conflict resolution style; instead, they adapt their reaction to conflict according to the issues at hand, the styles of those with whom they disagree, and the ends they hope to achieve.

Negative Impacts of Emotional Reactions

Everyone has emotions and emotional reactions to some people and events. However, research shows that being unaware of your own strong emotional reactions may have negative consequences, including:

- ✦ Narrowing vision and creativity
- ✦ Stifling curiosity, openness, and playfulness of mind
- ✦ Hindering ability to recognize nuances
- ✦ Distorting perceptions.

Receiving Feedback From Others

One of the challenges of participating on a research team is learning how other team members feel about you or the job you are doing. Even in conditions of high trust it is not always easy to give or receive honest feedback. This is especially true for team leaders. If you are a team leader, it is important to remember that your role will likely supersede your personal characteristics in the workplace, even in casual team environments where friendships exist. As team leader, your reaction to feedback—including your emotional response—is likely to have an impact on team members and “set the tone” for the team as a whole. It is especially difficult for people with less power or in subordinate positions to provide candid feedback, especially if you, as team leader, have the ability to impact their careers.

In recent years, “360-degree evaluations” have become a popular managerial and self-evaluation tool, particularly in circumstances where the ability to work well together is important. In a 360-degree evaluation, each person being evaluated receives feedback from peers, supervisors, and subordinates. To increase the likelihood of obtaining truthful responses, the feedback from peers and subordinates is often kept anonymous.

Of course, there are other steps one can take to encourage feedback outside of formal evaluation. The single most important factor in encouraging honest feedback is establishing an atmosphere in which disagreement and constructive criticism are welcomed. Conflict is a normal part of all relationships, including those between and among scientists. If this conflict is managed well, it can strengthen the scientific research process as well as foster mutual respect among team members. To establish such an atmosphere, team members must have a positive experience when they voice disagreement with the team leader or other team members. If your response to another team member’s expression of differences is defensiveness, rebuttal, ridicule, punishment, or exclusion—whether in private or public—team members will be unlikely to speak up, even when asked. However, if you meet team members’ efforts to voice disagreement with both receptivity and appreciation, you will begin to build a base from which others can voice their opinions—both positive and negative—to improve overall team function. While it may be impossible to get to the point of absolute honesty and frankness, it is possible to move further in that direction.

Conflict Resolution Styles

When you encounter conflict, you may rely more heavily on one style than on others, whether because of temperament or practice. But everyone is capable of using all five conflict resolution styles. Think about how different styles could be used in different situations.

Competing: When competing, you use whatever power seems appropriate to win your own position. Competing can involve “standing up for your rights,” defending a position you believe is correct, or simply trying to win.

Accommodating: When accommodating, you neglect your own concerns to satisfy the concerns of the other person. Accommodating might take the form of selflessness or yielding to another person’s direction or point of view.

Avoiding: When avoiding, you sidestep the conflict altogether.

Collaborating: When collaborating, you attempt to work with the other person to find a solution that fully satisfies the concerns of both. It means digging into an issue to pinpoint the underlying needs and wants of the two individuals.

Compromising: When compromising, you attempt to find an expedient and mutually acceptable solution that partially or even fully satisfies the concerns of both parties.

Note About Assessment Tools:

While assessment tools such as the MBTI, Thomas-Kilmann Conflict Mode Instrument, and 360-degree evaluations provide valuable information in a variety of areas, they are just one type of "tool" in your toolkit. Your toolkit must also contain a variety of skills, knowledge, and approaches. Just as a hammer in a handyman's toolkit will only get him so far in his work, he must also have a wrench, screwdriver, level, and the other tools necessary to satisfactorily complete a job. In much the same way, these various assessment tools contribute one piece to an overall whole.

If You're Ready

The following modules on topics related to building, leading, and participating on a team are the culmination of many discussions, experiences, observations, readings, and solutions that have helped us understand how highly integrated scientific teams have succeeded while others have not. We hope our findings will help you assess your readiness to participate on or lead a team, and we encourage you to take part in the exciting world of team science.

Notes

Whether you will be leading or participating on a research team, it is critical to understand what contributes to successful team functioning and what can negatively impact the development of a productive group. As science becomes ever more specialized, researchers increasingly need the support, input, and expertise of scientists from several niches to move their efforts forward. Yet bringing together individuals from various disciplines or specialties, and at different stages in their careers, is a task that requires forethought and care. After all, people from different disciplines often bring expectations, norms, and ways of thinking that are unique to their field. Teams often experience increased mutual learning by virtue of this diversity. If handled well, the process of integrating scientists from diverse backgrounds can result in the formation of a highly functioning group. If done haphazardly, the team may not endure.

How to Build a Team

There are many ways to go about building a research team—some more effective than others. If you are charged with or are interested in building a research team, there are several considerations to keep in mind:

- Bring together members with diverse backgrounds and experiences to promote mutual learning.
- Make sure each person understands his or her roles, responsibilities, and contributions to the team's goals.
- As a leader, establish expectations for working together; as a participant, understand your contribution to the end goal.
- Recognize that discussing team goals openly and honestly will be a dynamic process and will evolve over time.
- Be prepared for disagreements and even conflicts, especially in the early stages of team formation.
- Agree on processes for sharing data, establishing and sharing credit, and managing authorship immediately and over the course of the project.
- Regularly consider new scientific perspectives and ideas related to the research.
- When bringing on new team members:
 - ✦ Develop interview questions that require the candidate to articulate his or her interest and experience in working on a research team.
 - ✦ Ask for examples of how the candidate has successfully contributed to a team and what challenges he or she encountered.
 - ✦ When checking a candidate's references, inquire about his or her capacity to collaborate and function as a supportive member of a team.

A research team can be built from the top down (by leaders in their respective fields and/or organizations) or from the bottom up (by junior and senior scientists at the grassroots level). Both approaches can result in the development of highly effective teams.

A well-known example of the top-down formation of a highly successful research team was the one established by the World Health Organization (WHO) in 2003 to solve the spreading SARS (Severe Acute Respiratory Syndrome) pandemic. The WHO brought together 11 researchers from 9 countries to identify the pathogen responsible for SARS deaths. Once organized, the team quickly embraced several key principles of effective teams—frequent communication about data, results, and next steps; processes to share data and clinical samples; and a shared commitment to a concrete goal. As a result, a mere month later, the team determined that a previously unrecognized coronavirus was the causative agent of SARS.

Bottom-up teams form when scientists identify a common interest and come together to tackle a problem or achieve an agreed-upon goal. Examples of bottom-up teams and collaborations can be found at all research institutions, from simple collaborations to highly complex and interactive research teams. People will often be drawn together by a common interest and will self-assemble to collaboratively address a challenging question. With leadership support for their scientific endeavors, self-assembled multidisciplinary efforts can be highly successful.

Can Architecture Support Team Science?

The NIH Porter Neuroscience Research Center—named for former Illinois Representative John Edward Porter, a strong supporter of the NIH—was constructed with the specific intention of providing an environment to encourage interaction and communication among researchers. Phase I of the project, which was completed in 2004, was planned by a diverse group of individuals from multiple NIH Institutes, including scientists, engineers, facility managers, and others. The designers set out to create a space that would be flexible and house thematic research areas that cut across Institutes.

It is interesting to note that architects have recently been turning to research in the neurosciences for information about the “features of the environment that trigger various neural and physiological responses that...induce a sense of comfort or anxiety” (Sternberg & Wilson, 2006). Efforts to employ architectural means to support team science have addressed some concerns and raised new ones.

Case Studies

It's Working: Case Study 4

Most of Dr. Wu's team applied for their positions, and team members understood from the beginning that they would be working as part of a collaborative research team. During interviews, Dr. Wu was clear in communicating each team member's expected roles and responsibilities, processes for sharing data and credit, as well as the team's overall vision and goals. She then asked about each applicant's objectives and commitment to team science to determine compatibility. If the person indicated that he or she was more comfortable working as a solo investigator than as part of a team, Dr. Wu suggested that another laboratory or project might be a better fit. “It's a personality thing,” she said. “You can really tell a lot about what kind of team member someone will be by asking the right questions and being open to their answers.”

It's Not Working: Case Study 5

Dr. Anderson had come to the conclusion that several of his junior team members joined his team primarily because of the research funding he was able to offer. Once these team members had the resources they needed, they stopped attending team meetings and withdrew from interactions with members of the team. Other team members, especially senior researchers in leadership roles, continued participating in the team effort, but failed to share data openly or discuss research results honestly. Team members often did not interact directly and were openly resistant to considering alternative ideas or perspectives offered by other team members. "On paper we are a research team, but I get the feeling many team members are focusing on their own research," he said. "I guess they do not share my collaborative spirit."

Many lessons can be learned from these case studies and the interviews we conducted with scientists and researchers who are part of interdisciplinary scientific teams at NIH (see *A Note From the Authors* on page iii). In the world of biomedical science, tremendous value is placed on individual accomplishment; both the team leader and the participants need to be mindful of the balance between individual professional growth and the achievement of a scientific goal by the group. In the pages to follow, you will learn more about the importance of creating this balance, including strategies to carve out leadership roles for team members and to define success metrics for reviews and other evaluations to ensure recognition and reward (see *Sharing Recognition and Credit* on page 35).

Understanding Your Team's Evolution

The Model of Group Development developed by Bruce Tuckman in 1965 theorizes that research teams and other groups form and develop in critical stages to achieve their highest potential (Tuckman, 1965; Tuckman & Jensen, 1977). Nearly 45 years later, Tuckman's model is still cited and used within leadership courses and by organizational development experts. It is extremely helpful for teams to note these stages, which include the four originally described by Tuckman and a fifth he added years later, as their teams evolve.

1. **Forming:** The team is established using either a top-down or bottom-up approach.
2. **Storming:** Team members establish roles and responsibilities. This process may trigger disagreements or "turf battles" and reveal a reluctance to appreciate the perspectives and contributions of people from different disciplines or training. However, if collegial

disagreement is supported and premature pressure to consensus is resisted, people will begin to open up to one another.

3. **Norming:** Team members begin to work together effectively and efficiently, start to develop trust and comfort with one another, and learn they can rely on each other.
4. **Performing:** The team works together seamlessly, focuses on a shared goal, and efficiently resolves issues or problems that emerge.
5. **Adjourning or Transforming:** Two things can happen when a team accomplishes its initial goal(s):
 - ✦ Teams may come to a natural end. The team's dissolution should be celebrated and the accomplishments recognized and rewarded.
 - ✦ The team may take on a new project with a new goal, applying its ability to work together to solve a new problem.

Interviewing New Team Members

For team leaders, interviewing is a key part of bringing new talent into an existing team or building a team from scratch. In addition to reviewing a candidate's CV, letters of reference, and research statement, you may find it extremely informative to utilize different types of questions to be sure to gain insight into the individual's values and past performance as well as how he or she is likely to deal with everyday challenges that may arise. When conducting interviews, be sure to ask the potential team member to expand on his or her answers and give specific examples. In addition to listening attentively, watch for body language and visual cues that may provide additional insight.

Values-Based Interview Questions*

Values-based interview questions can help you learn more about whether a potential team member's values are consistent with the principles that guide your team. The first step is to identify the characteristics of an ideal candidate. Next, develop interview questions that will help determine if the candidate has those values or characteristics. Sample values-based interview questions include:

- ✦ Describe three things you particularly liked about your past job(s). What were the key ingredients that made those situations so agreeable?
- ✦ What would you do if you realized you had made a mistake in your work?
- ✦ In working on a research team, you may encounter some people who are more challenging to work with than others. Describe your approach to working collaboratively.

Performance-Based Interview Questions (Adler, 2007; Hale, 2002)

Performance-based interview questions can help you determine whether the candidate is capable of performing the job at stake. While a person's resumé says that he or she "led a team that successfully identified a gene that modifies disease susceptibility," performance-based questions

encourage the candidate to describe how this achievement was accomplished. In addition, ask the candidate to speculate on how he or she would approach a particular situation. For example, you might say: "The successful candidate in this position will be responsible for developing a policy for data sharing and communicating research results for our laboratory. How might you approach such a task?" Deeper questions such as these can help you determine how an individual may actually perform in the position and provide insights as to the candidate's potential for success on the team. Sample performance-based interview questions include:

- ✦ Describe a project that you led that had a tight deadline and its outcome.
- ✦ One project of great importance to the team is [explain project]. How would you approach it?
- ✦ Tell me about a time when you have led a team and a time when you have been a participant on a team.

Behavioral-Based Interview Questions (Fitzwater, 2000)

Behavioral-based interview questions can help you understand how a candidate may behave or react under certain circumstances and what skills he or she would bring to specific situations. Behavioral interviews are based on the premise that you will have a better idea of how an individual may function on your team if there is past behavior to assess. It is usually most helpful to present a specific scenario and then ask the potential team member to describe how he or she would behave in the situation at hand. After the question is answered, you can then discuss the impact of his or her behavior. Sample behavior-based interview questions include:

- ✦ There is considerable disagreement within your team about what should be the next set of studies in your project. How would you handle this situation?
- ✦ Your team has adopted a new policy that you think is overly restrictive. How would you respond?
- ✦ A fellow team member tells you he is upset; he says you did not take his idea for a new research direction under serious consideration. How would you respond?

* Janis Mullaney, Executive Officer, National Human Genome Research Institute, personal communication; Dona McNeill, Manager, Employee Services, Office of Management, National Institute of Environmental Health Sciences, personal communication.

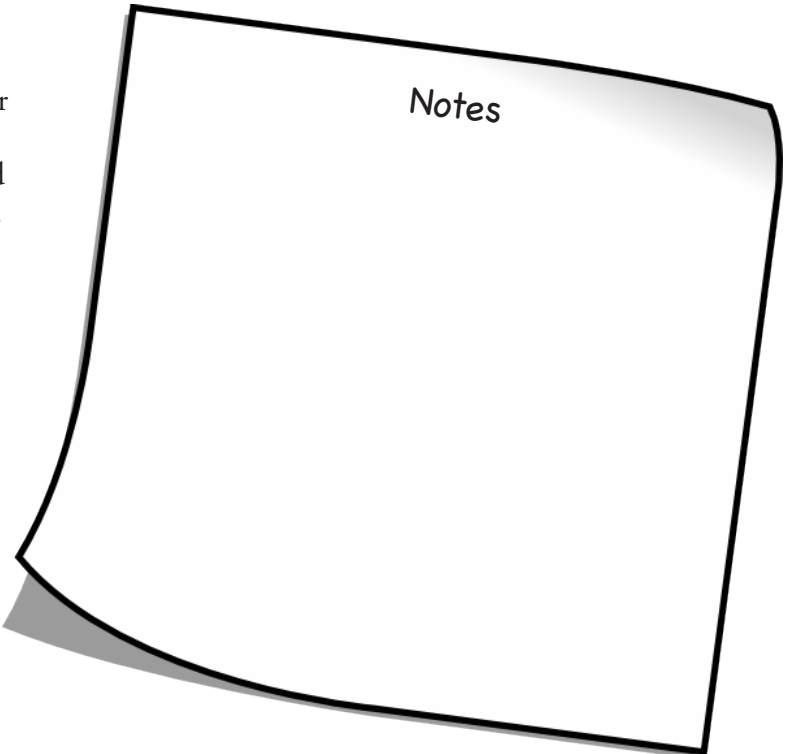
Ask Yourself: Is It Working?

When It's Working

- Team leaders seek members who are interested in being part of a research team.
- Team members seek out leaders who can guide their professional growth and development in the context of the team.
- During interviews, candidates and potential collaborators are made aware of the team's culture and the expectations for working together and sharing data.
- If a person joins the team and there is a bad fit, the individual either leaves of his/her own accord or is encouraged to find another project.

When It's Not Working

- Members prioritize their own objectives before the overall team goal.
- The leader fails to provide clarity around roles, responsibilities, and expectations for each of the team members.
- Individual team members begin working for their own gain at the expense of the team.
- Working through scientific, experimental, or personal challenges openly and honestly becomes difficult.



Take Aways

- Whether you are building a team or considering becoming part of a team, ask questions of team participants and listen carefully to their answers.
- Understand that teams evolve over time and may go through “rocky” periods before reaching peak performance.
- Make sure team members’ roles and responsibilities are clear to everyone involved.
- Agree up front on how to achieve open and honest communication, share data, and evaluate scientific achievement and progress.
- As a group, agree on expectations.

Let's be honest: Working with others means relying on them, and relying on others always entails some level of risk. Taking that risk requires some level of trust. It is almost impossible to imagine a successful collaboration without trust. On the other hand, a lack of trust almost always leads to the collapse of collaboration.

Trust is not a simple, one-dimensional variable. It is based on an assessment we make of another person's or group's abilities, honesty, reliability, and intentions. To experience trust, research team members must have confidence in the abilities of their colleagues to do good work, do it on schedule, produce reliable results, and openly share and discuss interpretations of data collected. Team members must also feel confident that their colleagues are committed to the collaboration, that they care about the interests and needs of others on the team, and that they are invested in the success of the team as a whole. Finally, trust requires faith in the honesty of one's colleagues—the belief that they will be truthful in their communications and in the conduct of their scientific research. Remember, also, that trust has to be built slowly over time by providing team members with positive shared experiences.

How to Foster Trust Among Team Members

- Structure activities that allow team members to learn about each other through various interactions.
- Hold weekly data meetings or case conferences—be sure that all team members have the opportunity to present data and receive feedback, as well as to hear data and give feedback.
- Model and teach team members how to give feedback that is critical and supportive.
- Encourage scientific debate and exchange—challenge ideas with the goal of making a decision or reaching a conclusion based on scientific information.
- Teach and train others.
- Receive instruction and assistance from others.
- Develop a process to handle disagreements over clinical issues or science or other lab issues.
- Ensure that team members follow through on their commitments.

Types of Trust

While we often think of trust as deeply personal, that is not always the case. Driving on a highway, for instance, entails some degree of trust in the other drivers but not in a way that is personal. This type of trust is known as “calculus-based” trust—it is often situation-specific and is contingent upon the assumption that people will conform to established norms or procedures. In other words, people do what they are supposed to do because the rewards for

doing so and punishments for not doing so are strong enough to ensure a reasonable degree of reliability.

In *The Negotiator's Fieldbook*, Roy Lewicki writes that calculus-based trust "... is most consistent with relationships that are largely arms-length market transactions or with the early stages of relationships that might become closer and more personal. In these relationships, the trustor (intuitively or explicitly) calculates the value of creating and sustaining trust in the relationship relative to the costs of sustaining or severing the relationship" (Lewicki, 2006). Clearly, this form of trust is not a sort of trust that depends on a deep or caring relationship between people. For the most part, professional and task-dominated relationships are built around this sort of trust.

On the other hand, "identification-based" trust is built around a sense of compatibility of goals or values or an intellectual or emotional connection. With this sort of trust, each party is confident that the group's shared interests or deep connection means they can act on behalf of each other. It is this trust that can endure and provide the platform for sustained collaboration and interactions. It is also critical for providing the foundation for effective communication, successful team building, and the sharing of data and credit (see *Building a Research Team* on page 15, *Communicating About Science* on page 29, and *Sharing Recognition and Credit* on page 35).

There are often connections between the two forms of trust. For example, calculus-based trust can provide the basis on which a more personal, identification-based trust can develop. Especially with scientists, for whom work is almost always more than just work, a strong and successful collaboration can lead to a deep relationship that is personal even if it is not intimate.

Two Forms of Trust

Calculus-Based Trust

- ✦ Characterized by openness, reliability, accountability, dependability, and consistency.
- ✦ Established by having processes and procedures in place that guide behavior and actions.
- ✦ Expectations are made explicit in written documentation that provides the foundation for communications and data sharing.

Identification-Based Trust

- ✦ Characterized by similar interests, goals, and objectives that support the shared values.
- ✦ Established through positive shared experiences and interactions.
- ✦ Over time, team members learn how others behave and interact and, based on these observations and experiences, create their expectations of individual contributions.

(Adapted from Lewicki, 2006.)

Case Studies

It's Working: Case Study 6

Team members on an interdisciplinary, multi-institutional research project established a publication and data analysis committee. This committee was charged with ensuring the team adhered to the International Committee of Medical Journal Editors (ICMJE) fair authorship guidelines and providing a forum in which decisions on authorship and related issues were openly made by a committee legitimized by all investigators. The committee was also empowered to review and approve data analysis plans and study-wide papers. The processes for submitting data analysis plans and papers were clearly defined by the committee. Over the course of several years, all issues that came before the committee were handled satisfactorily.

It's Not Working: Case Study 7

Dr. Salazar and Dr. Buchanan, two scientists from different institutions, were involved in a long-term collaboration. The two PIs did not develop a partnership agreement in advance and there were no explicitly agreed-upon guidelines for determining authorship. Dr. Salazar published a paper in a high-visibility journal using data that had been generated by postdocs in her lab as well as by postdocs in Dr. Buchanan's lab. Although Dr. Salazar acknowledged Dr. Buchanan's lab's contribution in the paper, none of the researchers from that lab were included as authors. Dr. Buchanan also disagreed with the way the data from her lab were presented in Dr. Salazar's paper. Later, when Dr. Salazar failed to address the concerns Dr. Buchanan raised, Dr. Buchanan contacted senior-level scientists in Dr. Salazar's organization to air her complaints. These leaders initiated a formal investigation into the charges. By this time, the two investigators no longer trusted one another and their collaboration ultimately came to a halt.

Ask Yourself: Is It Working?

When It's Working

- Trust provides a foundation for the team's success.
- There is a platform for open communication, discussion, and even disagreement.
- The team environment encourages sharing opinions and achieving consensus when appropriate.
- Data sharing and discussion of next steps are facilitated.
- Team members are willing to teach each other and support each other's work.
- Team members have confidence in each other's motives and commitment to the group's mission.

When It's Not Working

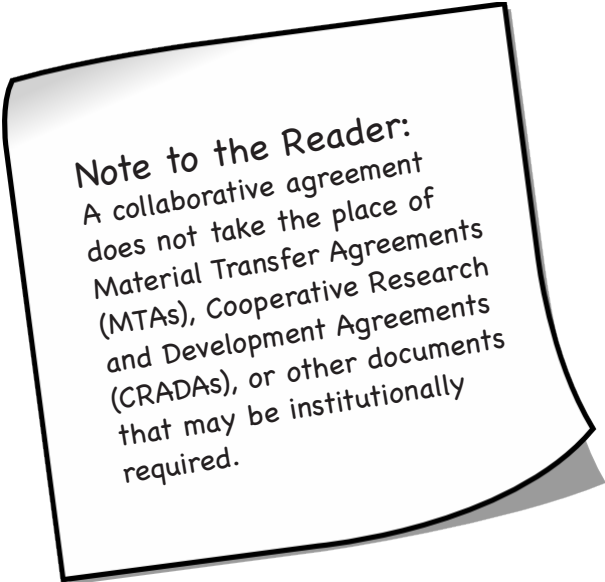
- Team members remain focused on themselves and their own efforts.
- The group cannot openly discuss scientific projects or issues involving team dynamics.
- Individuals are suspicious of others' motives and are less inclined to share data or other information that might help others advance their efforts.
- The collective discusses issues only at the most superficial level.
- Team members are more likely to see others in the group as competitors rather than as collaborators.

Creating the Foundation for Trust

So, what is the best way to begin to develop trust among those with whom you wish to have strong, highly collaborative scientific interactions? We believe that the scientific “prenuptial agreement,” or collaborative agreement, is the first and most important step toward a successful research partnership.* A collaborative agreement can lay the foundation for the continued relationship by putting a system in place that establishes and supports trust.

A collaborative agreement can serve several purposes. First, it can explicitly and precisely state the goals of the project and describe how each of the collaborators will contribute to the project. Second, it can delineate how to handle communications, data sharing, differences of opinion, and other project management process issues. Third, it can address the administrative aspects of the collaboration—finances, accountability, staffing, etc. And finally, in the current scientific environment, it also can provide an opportunity to reflect on potential conflicts of interest. A template for developing a collaborative agreement that explicitly states the team’s expectations, goals, and values is located in the *Appendix*.

A collaborative agreement, however, can only provide the framework within which the collaboration will occur. Implementing the agreement requires translating these aspirations into practice, and this requires structuring the working relationships in a way that engenders trust among the collaborators. It is helpful at the start of a collaboration to differentiate between what calculus-based trust provides to the team as opposed to identification-based trust, which will build slowly over time.



Note to the Reader:
A collaborative agreement does not take the place of Material Transfer Agreements (MTAs), Cooperative Research and Development Agreements (CRADAs), or other documents that may be institutionally required.

Take Aways

- Building and maintaining trust takes work; it is risky to place too much faith just in good interpersonal chemistry.
- There cannot be trust if collaborators are not explicit about what they expect from each other.
- Scientists need to attend to the quality of scientific and relational communications and interactions within their labs and among their collaborations.
- A written collaborative agreement can provide guidelines and processes for addressing every major issue that might arise in a collaboration.
- Trust is fragile—handle with care.
- The time to decide how to resolve conflicts is at the beginning of a collaboration before there are any conflicts to resolve.
- Trust is fragile: Handle with care.

* Prenuptial agreements are optional and typically entered into by individuals before they marry. The document allows future partners to determine, in advance, the ownership of their respective assets in the event of divorce or the death of one of the spouses.

Shared vision among team members is part of a highly functioning team's foundation. The lack of a shared vision can prevent or erode the development of a productive group. However, this does not mean that all team members must see the team in exactly the same way. Team members may each have a slightly different sense of the team's vision depending on their roles and responsibilities within the team or their stage of career development. What is most important is that each person understands the *overall* goals of the project and that the activities and responsibilities of each individual and group within the team are integrated in a collective effort to reach them.

How to Develop a Shared Vision

- Write a vision statement for your laboratory, collaboration, or team.
- Ensure that all team members can describe the team's goal, or the "big picture."
- Encourage all team members to articulate their own research goals and how these goals relate to the "big picture."
- Discuss as a group each team member's accomplishments and challenges and how these relate to the team's overall mission.
- Instill in team members a sense of ownership of their contributions to the team's goals.
- Encourage team members to accept responsibility and be accountable for their accomplishments and failures—without blaming.
- Credit team members for their contributions.
- Encourage sharing and mutual learning across disciplines to enhance the overall vision.

We have learned that each team member's understanding of the overall vision and goal for a project is influenced by his or her career stage and role. People at more junior levels, for example, often have a thorough understanding of their own project but may not fully realize that it is only one part of the overall vision. As the level of responsibility increases, however, individuals tend to have a greater depth and breadth of overall understanding. They are aware of what each team member is doing and how those concurrent efforts combine to support the mission of the team. Beyond this understanding, though, a hallmark of successful teams is that all members can articulate the feeling of being part of a larger whole and indicate that the work they are doing is helping to successfully achieve the vision.

Our research uncovered the risks that emerge when team members do not share a common vision. Group cohesion is strained when individuals cannot articulate the overall vision for the project or describe how their individual efforts contribute to the larger effort. A researcher may express less commitment to an overarching effort than to his/her individual

success. Without shared vision, group members are, in effect, not working on the same project. For this reason, they do not see themselves as being part of a “team.” Consequently, they may show evidence of low trust, lack of willingness to share data with other group members, desire to keep all credit to themselves, and poor communication with team members. In extreme cases they may even subvert one another’s work. Needless to say, these elements can compromise the ability of a team to effectively and successfully function.

Case Studies

It’s Working: Case Study 8

Dr. Henry recently joined a research team. Dr. Torres, the team leader, has set clear and tangible short- and long-term scientific goals for her team. Dr. Henry and his fellow team members are able to articulate the goals and understand how their research results and other contributions will help achieve the team’s overall vision. The team frequently discusses where it is going and how it wants to get there. In fact, once a quarter, Dr. Torres convenes the entire team to discuss the team’s progress toward its goals and whether adjustments need to be made. At these meetings, each team member again articulates his or her research goals and the team discusses how the pieces fit into the bigger picture.

It’s Not Working: Case Study 9

A PI, Dr. Cohen, and a branch chief, Dr. Millstrom, appeared to have a shared vision for the collaborative project in which they were involved. However, when it came to the implementation phase, it became clear they did not agree on how to achieve the vision. They were at odds about when to move the findings from the laboratory into the clinical setting. Dr. Millstrom argued that the preclinical results were sufficient. Dr. Cohen argued that the mechanism behind the preclinical data was unclear and until there was a better understanding of the results the project should not be advanced to the clinic. Mediators and experts needed to be brought in to help make the best decision for the research project.

A Process for Developing a Shared Vision

When labs come together for a collaboration, the PIs and possibly other investigators should establish an overall vision for the collaboration. Individuals can establish their own goals in support of (a) the overall vision and (b) their individual purposes.

The following process is one approach to establishing an overall vision. It challenges the group to consider the desired future state and builds meaningful consensus through the group interaction. There are four major questions in the facilitated process:

- ✦ Fast-forward to the future. It is five years from now and our collaborative project has been finished and has met with complete success. What is it that we have done to be so successful? (Participants identify and then prioritize the success elements.)
- ✦ What are the barriers to achieving this accomplishment? (Identify and rank.)
- ✦ Who owns the barriers? (Teams that don’t identify themselves as barriers are often missing a main point.)
- ✦ What will we do to remove the barriers?

Using this approach, the team establishes a vision, then develops an action plan to remove the highest-ranked barriers, and monitors their progress in achieving the end goal.

(Adapted from Belasco and Stayer, 1993, and personal communication, Brian Fitch.)

Ask Yourself: Is It Working?

When It’s Working

- Each team member knows what goals he or she is working toward and how they relate to the team’s overall goals.
- Team members share a sense of purpose and ownership.

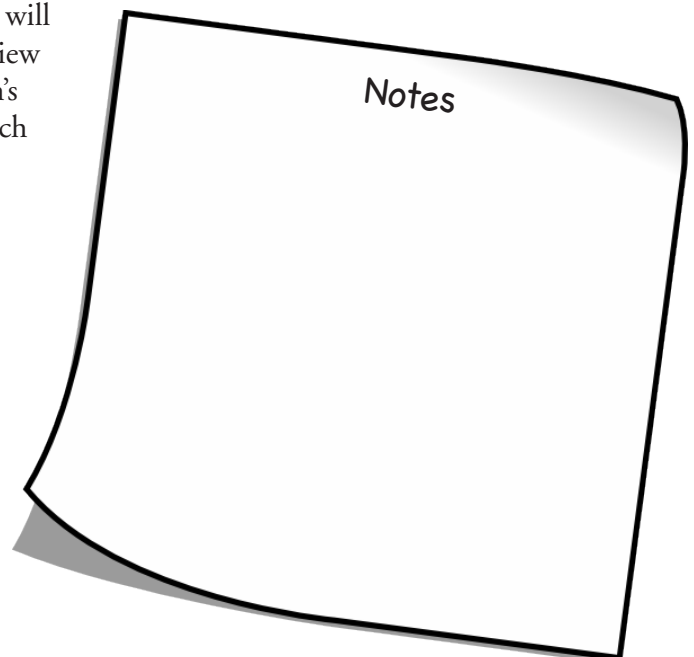
- There is a high level of commitment, responsibility, and accountability among all team members.
- Team members support—rather than compete with—one another.
- In achieving the shared vision, members are just as willing to share credit as they are criticism.

When It's Not Working

- Team members have difficulty understanding how their individual goals relate to the big picture.
- Team members are focused on their own individual achievements above the overall focus of the group.
- Team members tend to compete with—rather than support—one another.
- Cohesiveness among team members is weak; individuals are focused on personal projects, sometimes at the expense of another scientist's work.
- Team members find it difficult to share data and credit, leading to conflict and tension within the group as a whole.

Take Aways

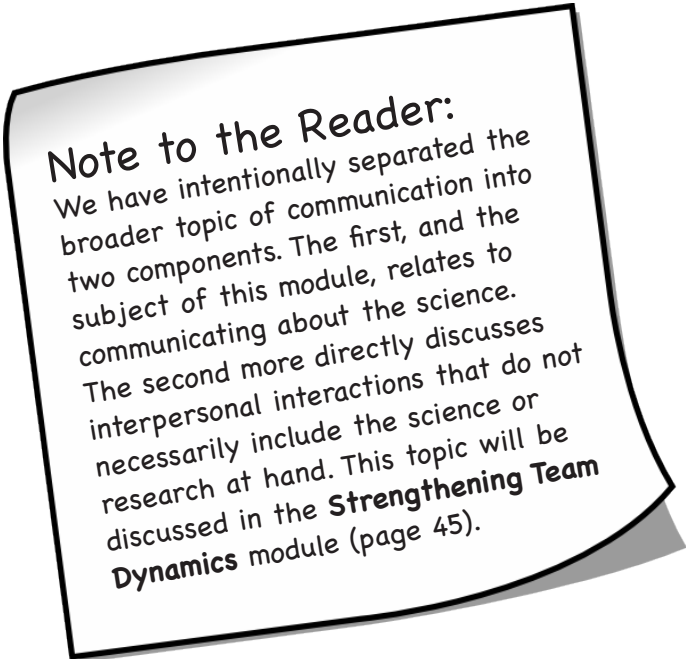
- Whether you are leading or participating on a research team, you must be able to articulate and commit to the team's overall goals.
- Each team member's individual research goals should be clearly stated and their importance should be recognized in the context of the team's effort.
- A team's vision is dynamic and will change over time; regularly review and revise (as needed) the team's vision statement and that of each team member.



Communicating with your team about science—including everything from scientific discourse to the discussion of data and the implications of research results—may be an easier topic for some people to handle than others. As you work through this module, you will see that much of what we have learned about success in communicating about science relies upon trust (see *Fostering Trust* on page 21).

How to Communicate About Science

- Ensure that all team members feel able to participate in discussions about data, methods, results, and other aspects of the science, as well as various issues affecting the group.
- Conduct regular meetings in which team members take turns presenting data and providing feedback.
- Establish ground rules for how people are expected to communicate with each other during meetings.
- Develop an expectation that data and results will be shared with all team members as well as procedures for doing so.
- Convene a journal club or other forum to discuss current topics and methodologies.
- Respectfully address and resolve debates over science or scientific results through literature reviews, experimentation, outside expert opinion, and other relevant methods.
- Help people translate when there are differences in concepts, methodologies, and frameworks.
- When disagreeing, be sure to disagree with the idea, not the person.
- Provide an environment and opportunities for team members to talk informally about their work.
- Embrace the notion that differing opinions may hold the seeds to creativity and important new ideas.
- Support the contributions of team members at all levels of seniority.



Note to the Reader:
We have intentionally separated the broader topic of communication into two components. The first, and the subject of this module, relates to communicating about the science. The second more directly discusses interpersonal interactions that do not necessarily include the science or research at hand. This topic will be discussed in the **Strengthening Team Dynamics** module (page 45).

Dialogue vs. Debate

The research enterprise is founded on exploring and uncovering new scientific truths and explanations. Understanding, interpreting, and disseminating research results requires elements of both dialogue and debate.

Dialogue is collaborative—two or more sides work together toward common understanding.

Debate is oppositional—two sides oppose each other and attempt to prove each other wrong.

In dialogue, because finding common ground is the goal, one searches to find or create a basis for agreement or consensus.

In debate, winning is the goal and one searches for differences and weaknesses.

Dialogue creates an open-minded attitude and an openness to being wrong and to change.

Debate creates a closed-minded attitude and a determination to be right.

In dialogue, one listens to the other side(s) in order to understand, find meaning, and find agreement.

In debate, one listens to the other side(s) in order to find flaws and develop counter-arguments.

In dialogue, one searches for strengths in the other positions.

In debates, one searches for flaws and weaknesses in the other positions.

Dialogue helps to reveal and re-examine assumptions that may be feeding the conflict.

Debate defends assumptions as unquestionable.

Dialogue opens the possibility of reaching a better solution than any of the original solutions because it is structured so that each participant can contribute to the solution.

Debate defends one's own position as the best solution and excludes other solutions.

Dialogue involves a real concern for the other person and seeks to not alienate or offend.

Debate involves countering the other position without regard for feelings or relationships.

(Adapted from Berman, Burt, Mayo-Smith, Stowell, & Thompson, 1997.)

Among the scientific teams we studied, those that were highly integrated had established a concrete schedule of activities that guided the work of the group. In general, they held weekly lab meetings to talk about data and results and had regular journal club meetings where relevant papers, methodologies, and/or scientific approaches were discussed; in addition, each group member presented a formal seminar at least once per year. Differences of opinion or alternative interpretations of presented data were addressed from a scientific perspective rather than considered personal affronts, and all members of the team, regardless of their career level, were invited and expected to contribute to all discussions. The groups intentionally revisited their goals and objectives on a regular basis and redefined them as needed to align with the most recent data and results. Strong communication about the science provided for a solid platform on which to move the science forward and clearly articulate the mission, goals, and objectives of the team.

We find it useful to differentiate between (scientific) disagreement and (interpersonal) conflict. The paradoxical task of research teams is that they must become a place where, simultaneously, disagreement is free and conflict is contained. Science thrives on disagreement; it is the motivator for scientific progress. Interpersonal conflict is an inevitable part of human interaction and, if not managed well, can be tremendously destructive. Of course, scientific disagreements sometimes segue into personal conflicts, especially when scientific disagreements become personalized. That is why it helps enormously to

depersonalize scientific disagreements. At the outset of any collaboration it is important that a scientific team decides how its members will address both scientific disagreements and interpersonal conflicts. Whereas interpersonal conflict can disrupt the effective working of a team, scientific disagreement, if handled properly, will not threaten the working relationship. However, it is helpful if a team agrees to structure regular opportunities for communication and establish shared attitudes and norms regarding both conflict and disagreement (see *Handling Conflict* on page 39).

Clearly, scientific disagreements are different from interpersonal conflicts, but they are also different from disagreements in other areas—such as politics or values—which are generally addressed or “settled” by debates during which each side attempts to win by proving the other wrong. In science, the process of addressing disagreement is more important than the initial positions in the disagreement. Scientific disagreements combine features of both debate and dialogue (see inset box on page 30). A line of scientific inquiry can begin with disagreement; the disagreement is then the basis for hypothesis formation and the first step towards a fact-based exploration for fundamental understanding. Although science can be incredibly competitive, it is not meant to be guided by either a primary concern for preserving relationships or a desire to win the argument regardless of the relevant facts. The Nobel Prize-winning behavioral scientist Daniel Kahneman has actually developed and employed a methodology of *adversarial collaboration* that attempts to exploit the strengths of both dialogue and debate and also elevates science above personal rivalry (Mellers, Hertwig, & Kahneman, 2001). Looked at from the broadest perspective, science is a form of adversarial collaboration in which people with competing perspectives work toward the solution of shared problems and puzzles (for more on adversarial collaboration, see inset box in *Handling Conflict* on page 42).

Case Studies

It's Working: Case Study 10

Dr. Andrews, a tenured scientist, was asked to join a scientific research team that was formed after a grassroots effort met early success and gained the favor of the Institute director. Her expertise in statistics would fill a gap for the research team, which was preparing to initiate a new clinical trial. The team leader explained to Dr. Andrews that the team was highly integrated and that they attributed the quick pace of the research progress to regular meetings at which results and next steps were discussed. When Dr. Andrews agreed to join the team, she received the meeting schedule, which included both data-sharing and strategic sessions; she then revised her own schedule to accommodate the new commitments. While attending these new meetings meant Dr. Andrews needed to resign from a committee on which she was proud to serve, she understood that a commitment to this new group was among her highest priorities. She quickly became accustomed to very dynamic group meetings during which everyone participated and challenged the presenters. When her turn came, she welcomed the discussion around her analyses and ideas, which enhanced her contributions to the ongoing experimental design of the protocol.

It's Not Working: Case Study 11

Dr. Polczyk's branch conducts monthly meetings to discuss experimental data, interpretations, and next research steps. The meetings are largely perfunctory in nature. It is expected that they will occur, but minimal effort or enthusiasm is invested. At these meetings, the presenter is rarely asked to clarify his or her data and is seldom asked questions or for more information; the discussion is brief and everyone is eager to get back to his or her own work. When questions are asked, the presenter is usually defensive and guarded in what he or she will share with the broader group. There are rarely questions that challenge a presenter's interpretation of data.

Ask Yourself: Is It Working?

When It's Working

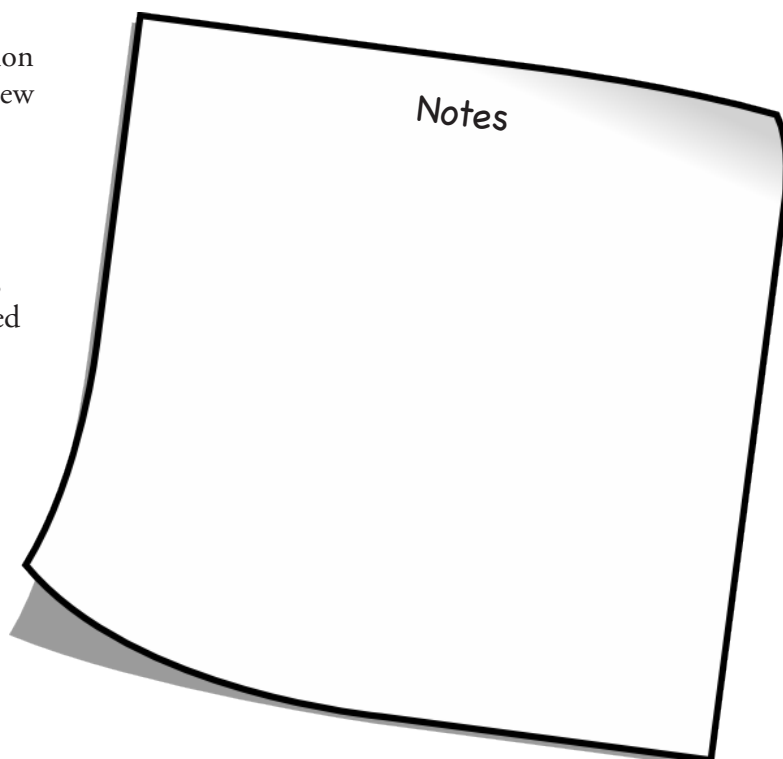
- Team members share recognition of each other's contributions to the research.
- Team members develop a common language for the project, eliminate or clearly define discipline-specific jargon, and translate across disciplines.
- Open discussion, differing opinions, and constructive criticism are encouraged and lead to healthy scientific dialogue (see page 30 for distinctions between healthy dialogue and debate).
- Over time, team members have the capacity to integrate the perspectives of others into their thinking and into hypothesis generation.
- The team works on projects in which everyone can see a path to clinical or scientific application.

When It's Not Working

- Experienced scientists feel like novices as they look for information in unknown surroundings and attempt to become oriented in new intellectual communities.
- Team members harbor concerns about personal image and reputation.
- There are "turf wars" and other indicators that individuals are defensive and/or hoarding data, reagents, or other resources.
- There is less focus on the science and more on the personal aspects of the team's interactions.
- Separate "factions" emerge within the team, establishing artificial barriers to scientific discussion; the team may engage in "unhealthy agreement" to avoid conflict.
- Members approach scientific discussions as debates and may become combative (see page 30 for distinctions between healthy dialogue and debate).

Take Aways

- Expect that all group members will participate in lab meetings, journal clubs, and other scientific discussion that facilitates the direction of the research project.
- Establish an infrastructure that guides behavior, helps the team become comfortable having dynamic scientific discussions and debates, and leads to strong collaborative relationships.
- Learn how and encourage others to discuss and debate science as a component of professional growth and development.
- Remember that open scientific communication and consideration of new ideas and perspectives can result in more rapid achievement of accomplishments and take research into new, previously unconsidered directions.



Of all the aspects of team science, sharing recognition and credit is among the most difficult to master. Professional recognition is important regardless of where a researcher is on his or her career path: it plays a role in tenure decisions, grant submissions, promotions, scientific awards, and acceptance to prestigious organizations, among other things. For decades, scientists have largely been recognized—and thus rewarded—for their individual accomplishments. However, support is increasing for the idea that contributions to team science should be considered along with individual achievement, making it important that teams distribute recognition and credit thoughtfully and fairly.

How credit is attributed can vary greatly from team to team, but the decision about how to share credit will impact all team members. The best time to make these decisions is either before work begins or as early as possible. Waiting until problems emerge can jeopardize the work as well as relationships among team members. Sometimes it is not possible to determine order of authorship at the outset of a collaboration. In these circumstances, it is important that collaborators agree in advance on the criteria that will be used for making decisions about authorship.

How to Share Recognition and Credit

- Build and maintain trust among team members (see *Fostering Trust* on page 21).
- Unambiguously assign or negotiate roles and responsibilities for the various team members—this is especially important for team leaders.
- Establish as early as possible a process and criteria for determining how authorship and other forms of credit will be decided. Ideally, this will be laid out in a collaborative agreement prior to starting the project (see *Creating the Foundation for Trust* on page 24).
- Create an approachable means by which team members can raise concerns about how credit is being or will be determined as soon as potential problems emerge.
- Agree early on in your scientific relationship who will be responsible for answering questions and responding to outside inquiries about various scientific aspects of the project.
- In public presentations, identify team members and explicitly acknowledge their contributions to the research endeavor.

The formation of highly productive, integrative research teams has outpaced institutional mechanisms that support, review, recognize, and reward individuals who contribute to these collaborations. For research teams to flourish, there must be paradigm shifts for both scientists working in teams and the organizations that evaluate their work.

Institutional support is particularly critical for promoting the success of existing teams as well as for nurturing new ones. At NIH, there are several examples of changes that have been made to help shift the perception that recognition and reward for team science projects are lacking. Most notably, in 2006, NIH modified its intramural tenure evaluation guidelines to include recognition for participation in team science. The guidelines indicate that substantial impact of independent pursuits, as well as those characterized as team science, will qualify an individual for recognition for tenure. Another NIH effort recognizing the importance of collaboration was the establishment in 2007 of a grant application mechanism for multiple-PI projects.*

The NCI Center for Cancer Research has also revised its site-visit guidelines to include the evaluation, recognition, and reward of team science (see inset box).

The Center recognizes that while not all investigators invest time and devote resources to team science, those who do should be rewarded for making substantial contributions to such efforts. All members of site-visit teams are provided with formal guidance and evaluation criteria related to team science to ensure that they understand the importance of these efforts and how to appropriately recognize and reward them.

Leading medical and research associations have also begun to recognize that there are research accomplishments that are difficult to attribute to one individual. The American Association for Cancer Research, for example, has created the Team Science Award that recognizes and intends to catalyze interdisciplinary approaches to translational cancer research. Additionally, many journals now have explicit policies about how joint authorship should be determined, and some even require that the contributions of each author be clearly delineated (e.g., designed experiments, conducted experiments, analyzed data, wrote paper).

NCI Center for Cancer Research Criteria for Evaluating Contributions to Team Science

If the PI is involved in collaborative, multidisciplinary, and/or interdisciplinary research:

- ✦ What is his/her role in driving the project(s) forward?
- ✦ Is she/he leading a major effort within the project or making key scientific contributions to it?
- ✦ What accomplishments/achievements can be attributed to the PI?
- ✦ Was the contribution essential for the overall success of the project?
- ✦ To what degree did the contribution influence the overall outcome/direction of the project?
- ✦ Was the contribution original rather than a reproduction of the work of others (e.g., did the PI develop software with novel, original features that will be used by others in the field, or did the PI merely modify existing software to make it compatible with the workflow of the project)?
- ✦ For PIs whose research is mainly collaborative, how is the contribution of the individual PI regarded in the PI's field of research?

* To view NIH tenure guidelines, visit <http://www1.od.nih.gov/oir/sourcebook/prof-design/tenurecriteria.htm>. For information on NIH multiple-investigator grants, see http://grants.nih.gov/grants/multi_pi/.

Case Studies

It's Working: Case Study 12

A collaborative research team set up a publications committee to actively address authorship issues from the very beginning of the project. The leader, Dr. Kamela, encouraged team members to generate and present to the group their proposals for potential experiments and get their ideas out into the open. Dr. Kamela also made explicit the expectation that the resulting data would be shared and discussed openly with the team. The team agreed on clear and specific authorship rules and how they would share credit. The publications policy was included as an appendix on every research plan.

It's Not Working: Case Study 13

Two fellows from different labs were working, at the direction of their supervisors, on a collaborative project. While the scientific question was clear and the work was distributed based on expertise, authorship had never been discussed as an aspect of the collaboration. When it was time to write the paper, both fellows assumed they would be first author. A heated and emotional dispute erupted when it became clear that neither one would give up his position of thinking he should be first author. Accusations of discrimination, poor-quality research, lack of intellectual contributions, among others, were made. Many hours of valuable time over many days were spent trying to come to a resolution. The supervisors continued their collaborations; the fellows, however, remained bitter and frustrated.

Ask Yourself: Is It Working?

When It's Working

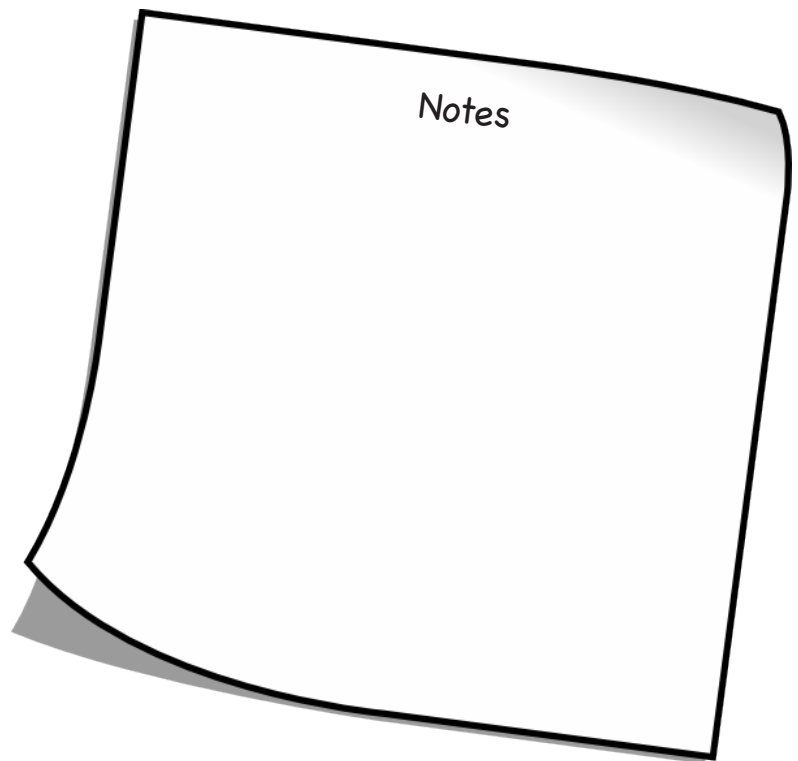
- Credit and authorship agreements are put in place prior to starting a new aspect of a project. The agreements outline:
 - ✦ Roles and responsibilities of each team member
 - ✦ How credit and authorship will be attributed for meeting abstracts, papers, intellectual property, etc.
- An environment of trust is created, allowing group members to willingly and openly discuss any issues or concerns that arise.
- Team members share data, discuss interpretation, and jointly plan next steps.

When It's Not Working

- Team members resent their supervisors and colleagues because they think they should have gotten credit when they did not.
- Team members are willing to accept credit and recognition but unwilling to give it in return.
- Communications are troubled, and issues and concerns of team members are not openly discussed.
- Members are unwilling to ask for agreements in the early stages of the scientific collaboration.
- Personal and professional relationships suffer.

Take Aways

- Clearly define project roles and responsibilities for each team member.
- Develop agreements for how credit for research accomplishments will be attributed.
- Have a clear understanding of authorship responsibilities early in the life of the project.
- Be mindful of team members' career development when developing agreements:
 - ✦ For whom is the credit and recognition most critical?
 - ✦ Are there any team members who can begin letting more junior members have greater recognition? This may take the form of authorship, corresponding authorship, and/or presentation of invited talks.
- When joining an organization, ask it to outline how your contributions to team science will be formally reviewed and recognized.



Conflict is about differences; it exists when two or more parties disagree, compete, or perceive that their interests are incompatible. Conflict is both an inevitable and a necessary aspect of human interaction. Social cohesion emerges from engaging in and resolving conflicts. For research teams, conflict can be both a resource and a challenge—a resource because disagreement can expand thinking, add new knowledge to a complex scientific problem, and stimulate new directions for research, and a challenge because if it is not handled skillfully, conflict impedes effective research team functioning and stifles scientific advancement.

When people are faced with conflict situations they are often stressed and, as a result, are not at their best. Understanding one's own preferred style when in a conflict situation can be helpful (see *Conflict Resolution Styles* on page 12). Many people, and scientists in particular, fear conflict and tend to avoid it. But for members of a scientific team, ignoring problems and avoiding conflicts can undermine the research endeavor, not to mention progress. If you avoid conflict, you cannot understand what led to it. And, if you are unable to understand and explore the source of the conflict, you are also unable to resolve it. Handling conflict well requires both a certain attitude and particular conflict resolution skills. A successful team knows how to constructively engage in conflict. An effective team leader is not afraid of conflict because he or she knows how to engage conflict when it emerges.

Dimensions to Explore When Facing Conflict:

- ✦ The parties to the conflict and their personalities, emotions, thoughts, motivations, values, ideologies, and/or identities
- ✦ Interpersonal dynamics, including communication, intimacy, rivalry, competition, power, and hierarchy
- ✦ Organizational structure and dynamics, such as roles and responsibilities, rules, policies and procedures, and organizational norms and values

How to Handle Conflict

If you are leading or participating on a team, think about the following steps for managing and resolving conflict (adapted from Cloke & Goldsmith, 2000):

- *Understand the culture and the context of conflict*—seek out the meaning of the conflict for yourself and/or the other parties.
- *Actively listen*—assure others you have heard what they said and ask questions to confirm your understanding.
- *Acknowledge emotions*—they will likely be part of the conflict, but expressing them and hearing them can help lift barriers to resolution.
- *Look beneath the surface for hidden meaning*—hidden fears, needs, histories, or goals may be the underlying source of the problem.

- *Separate what matters from what is in the way*—get away from discussing who is right or wrong and focus more on how to satisfy mutual needs.
- *Learn from difficult behaviors*—let those experiences help you develop your skills in managing difficult situations and having empathy for and patience with others.
- *Solve problems creatively and negotiate collaboratively*—this also means committing to action.
- *Understand why others might be resistant to change*—the problem could be an unmet need.

When dealing with conflict, it is important to recognize people's tendencies to overemphasize the importance of personal and interpersonal dimensions and underestimate the significance of organizational factors. Personal and interpersonal factors are usually quite visible and, in conflict situations, often quite dramatic. By contrast, organizational factors often operate outside of our immediate awareness. For example, if there were to be a conflict between two postdocs in a lab, your first instinct may be to consider the personalities of each postdoc, citing the aggressiveness of one or the reclusiveness of the other. However, an alternative approach that might get to the root of the conflict would be to consider the competition

Listening: The First Step Toward Problem Solving

Listening is so important because it is the first step toward problem solving. If you are not able to correctly understand the conflict, you cannot work with others to solve it. It is common, however, for people in conflict to focus only on their own needs and interests. Often, they doubt the legitimacy of the other party's needs, especially when they assume that their needs and those of the other party are incompatible. Typically, people involved in conflict assume that they are necessarily adversaries. Skillful listening helps you to gather the information you need to reframe a conflict as a joint problem and build the rapport and trust that is necessary to begin a process of jointly solving the problem through the collaboration of the disputants.

Among the most common missteps that many people, especially new team leaders, make when others approach them for help in resolving a conflict are:

- ✦ Immediately trying to solve the problem, rather than listening
- ✦ Interrogating people, rather than listening
- ✦ Prematurely analyzing the problem

- ✦ Saying how much they understand the problem regardless of the content.

True listening is a far more comprehensive endeavor than simply hearing someone talk. It is a multifaceted effort that includes attending to the speaker's words, tone of voice, and body language.

There are several components to effective listening.

- ✦ *Visibly "Tuning-In"*—Face others directly, adopt an open posture, make eye contact, and relax.
- ✦ *Listening Actively*—Focus exclusively on the person speaking, make efforts to connect, and be open to what others have to say.
- ✦ *Listening Accurately*—Paraphrase others' points to ensure that you understand and, if something is unclear, ask for more information.
- ✦ *Listening for Meaning*—Restate the issue or problem and request feedback on your understanding, and ask as many questions as needed for full understanding.

(Adapted from Egan, 2001.)

Principled Negotiation

In a team setting, the assumption that conflict is bad or that two people in conflict are necessarily adversaries can be incredibly destructive. Rather, if all parties can see their conflict as a joint problem, they can entertain the idea of working together toward a joint solution. The end goal is to negotiate in a principled way rather than in a manner that resembles fighting.

Principled negotiation has four steps:

- ✦ Separate the people from the problem.
- ✦ Focus on interests, not positions.
- ✦ Invent options for mutual gain.
- ✦ Insist on using objective criteria to evaluate options.

The aim of such negotiation is to find a solution that is acceptable to all parties and leave all parties feeling that they've achieved something. In addition, an ideal outcome is that all parties believe that their ability to manage and resolve conflict has been enhanced by the very way they have negotiated.

(Adapted from Fisher, Ury, & Patton, 1991.)

the postdocs feel in vying for the PI's favor. Not surprisingly, it is less common to identify the ways in which the PI may have inadvertently sparked the conflict by failing to ensure that each postdoc clearly understood his or her role and responsibilities as they related to the postdocs' individual projects. The PI may have neglected to discuss how each postdoc's specific project is integrated into the greater whole and important for the overall vision of the team's research endeavor (see *Developing a Shared Vision* on page 25).

Scientific teams are necessarily diverse, which means they contain within them significant differences. By itself, diversity of thought, opinion, approach, or identity is neither good nor bad; what matters is how it is handled. Critically examining the culture of a team can often provide insight into understanding why differences in personal attributes that could be an asset for a team instead develop into a source of conflict and disharmony.

Case Studies

It's Working: Case Study 14

Dr. Willoughby, a postdoc, complained to her team leader, Dr. Franke, that a senior technician on the project, Dr. Tuma, was withholding data and was unwilling to keep her informed about the studies he was conducting. Dr. Tuma independently reported that Dr. Willoughby was treating him abusively and claiming his ideas for herself. Dr. Franke quickly realized it was important to tackle this conflict head on and invited both individuals to a neutral place for a discussion. After listening carefully to each of them, Dr. Franke became aware that Dr. Tuma was having difficulties managing boundaries and setting limits in his working relationship with Dr. Willoughby. A voraciously curious researcher with seemingly unlimited energy and a willingness to spend day and night in the lab, Dr. Willoughby would quickly design new experiments based on the studies and results of others on the research team. Other team participants were able to capitalize on her enthusiasm and work collaboratively with her. For reasons of personal history and style, Dr. Tuma experienced her curiosity as intrusiveness and saw her eagerness to build on the work of others as if she were taking ideas away from them; he felt that his contributions to the team were being threatened. Dr. Franke helped the two scientists negotiate an agreement about how they would work together, including rules about sharing data and communicating about each other's studies. The two then jointly designed a process by which they would each be expected to obtain agreement from the other about building on the other's work or collaborating.

It's Not Working: Case Study 15

Dr. Lewis, a team leader who recently assembled a new research group to address a thorny scientific issue, announces that she wants everyone to focus their energies on research and that she does not want to be bothered with petty personal disputes that arise among participants. "I expect you to work out among yourselves whatever differences may arise," she explains in her introductory discussion with every person who joins the team. After an initial period of harmonious interaction among members of the group, two postdocs with different supervisors begin to quarrel about access to the electron microscope and other team resources. Unable to resolve their differences, the two soon begin to have disagreements about cleaning the shared equipment after use and the usage and purchase of reagents. The tension between the two begins to negatively affect the overall group dynamic and functioning until one of the postdocs approaches Dr. Lewis to inform her that he is leaving the team.

Adversarial Scientific Collaboration...

...is a joint scientific investigation carried out by two or more individuals or research groups who have proposed conflicting hypotheses in an effort to resolve the issue in dispute (adapted from Mellers, Hertwig, & Kahneman, 2001).

The goals of adversarial collaboration include:

- ✦ Empirical resolution of scientific disputes through a facilitated collaboration
- ✦ Jointly designed studies that speak to disputed issues and narrow or clarify differences
- ✦ Agreement of all parties on an experimental design and approach for resolving a dispute
- ✦ Conduct of agreed-upon tests with the help of a neutral third-party scientist arbiter/mediator.

Preconditions

All parties must:

- ✦ Acknowledge the possibility that conflicting hypotheses might be the result of differences in the way experiments have been conducted.
- ✦ Engage a mutually agreed-upon and trusted third party
- ✦ Ensure that differences are not too deep or too philosophical

- ✦ Agree that curiosity about differences is stronger than one's commitment to his or her stated position.

The Process

All parties must:

- ✦ Perform a systematic review of relevant studies.
- ✦ Formulate hypotheses.
- ✦ Discuss and develop procedures to test hypotheses.
- ✦ Implement procedures.
- ✦ Analyze and re-analyze data
- ✦ Engage outside experts as needed.

The Risks

- ✦ Ego threatening
- ✦ Possibility of being wrong
- ✦ Personal animosity or competition
- ✦ Ideological/theoretical/paradigmatic differences

Successes

- ✦ Surprising results
- ✦ Insightful discussions

Ask Yourself: Is It Working?

When It's Working

- All team members—from team leaders to postdocs—are attuned to potential conflicts among team members, have established processes to address conflicts, and are comfortable intervening should a conflict arise.
- The team maintains high expectations of interpersonal civility (see *Fostering Trust* on page 21 and *Strengthening Team Dynamics* on page 45).
- Team members openly explain their methodologies, hypotheses, rationales, and scientific perspectives.
- Once recognized, ambiguities over team members' roles and responsibilities are addressed proactively.
- The team leader conveys and demonstrates to team members that conflict can have a positive impact—from improving group cohesion and enhancing research to promoting team goals.

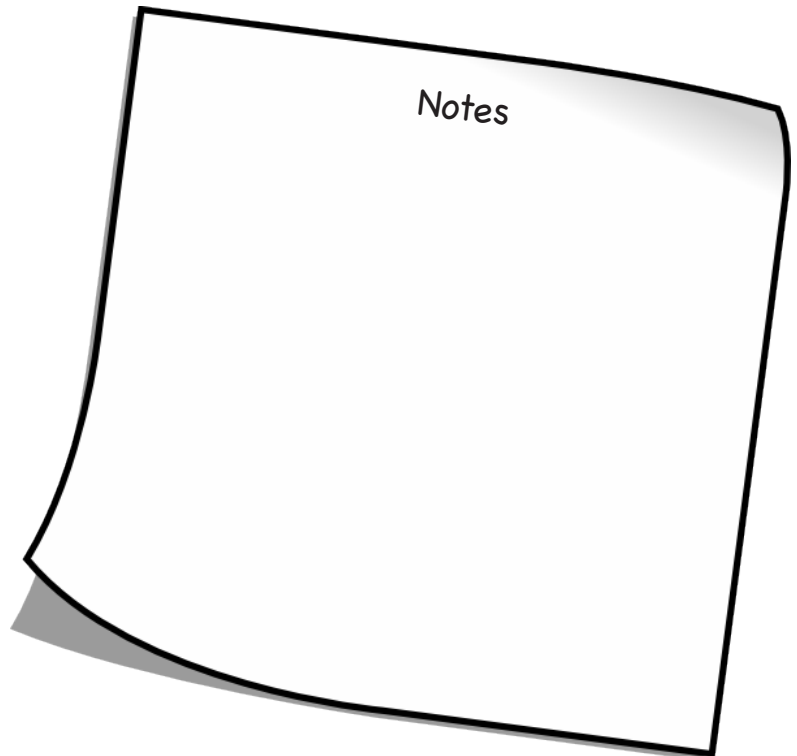
When It's Not Working

Team members, including the team leader:

- Are unaware of interpersonal conflict(s) within the team
- Do not listen to concerns, engage in mediation between colleagues, or seek out other third-party resources to serve as neutral intervenors
- Are unaware of or avoid acknowledging other team members' motivations and needs or the “deeper” meaning behind the conflict
- Fail to listen carefully to team discussion
- Interpret conflict as unhealthy when it is actually constructive
- Misread a lack of argument or challenge as agreement.
- Overestimate team members' ability to work together as a team.

Take Aways

- When handled skillfully, conflict can be productive and provide opportunities for creativity. If it is handled poorly, it can undermine a team's functioning.
- Ignoring conflict is a sure way to guarantee that it will remain alive and perhaps worsen.
- Resolving conflict requires individuals to take the time to understand what is driving it.
- Team leaders must develop thorough listening skills to thoughtfully and fairly intervene in conflicts; they can then encourage and mentor team members to learn and use those same skills to listen to one another and begin to understand differing opinions and perspectives.
- Teams should be proactive and establish processes to handle conflicts, ambiguities, or other concerns when they arise.



Team dynamics encompass the many characteristics and interactions of team members and how these, in turn, influence individuals' attitudes and behavior and, subsequently, the functioning of the group itself. When considering the factors that contribute to positive team dynamics, we find that many interdependent characteristics of successful teams are at play, including good communication, effective conflict management, strong leadership, shared goals, shared recognition, and the development of interpersonal trust (see the *Table of Contents* to locate modules on these topics).

Scientists, however, are sometimes impatient with tasks associated with team dynamics; they prefer to be doing the research, not talking about how they are getting along. However, for any team to be successful, it must spend some amount of time attending to the team's dynamics.

How to Strengthen Team Dynamics

- Schedule regular meetings to check on how the team is functioning.
- Foster an environment that is collegial and nonthreatening.
- Recognize the strengths that each team member brings to the group.
- Encourage open and honest communication.
- Identify personnel issues early and address them swiftly.
- Recognize that individual success reflects the success of the team.
- Find ways to integrate individual career needs with the achievement of team goals.
- Stay attuned to each other's needs.

Factors That Prevent Development of a Strong Team

In thinking about team dynamics, it may be helpful for you to compare the characteristics of successful teams with the indicators of failed teams. In *The Five Dysfunctions of a Team*, Patrick Lencioni identifies five traits that characterize dysfunctional teams:

- ✦ Absence of trust
- ✦ Fear of conflict
- ✦ Lack of commitment
- ✦ Avoidance of accountability
- ✦ Inattention to results

Successful teams are alert to the signs of these dysfunctions and take steps to confront and overcome them. A small but consistent amount of attention to team dynamics can pay off tremendously in terms of improving team morale and performance.

(Adapted from Lencioni, 2002.)

Strengthening Team Dynamics

As many can attest, dynamics are not as tangible or easy to define as the characteristics listed above; they can be more easily recognized when considering a team from a “few steps back.” Taking time to examine how things are going can make a big difference. The chart below is one example of a simple team or collaboration assessment form that can structure such an examination.*

Evaluation for Scientific Collaborations: Relationship and Performance					
Indicators	Poor	Marginal	Satisfactory	Good	Excellent
<i>Relationship Indicators</i>					
Communication					
Process for Resolving Disputes					
Adequate Notice of Problems					
Responsiveness of Parties to Concerns Raised					
Level of Trust Among Participants					
Openness					
Ability to Work as a Team					
<i>Performance Indicators</i>					
Availability of Resources					
Keeping to Schedule					
Commitment of Participants (Individuals/Leaders)					
Attitude of Participants					
Expectations					
Barriers (Fewer Barriers = Higher Rating)					
Synergy					

* Adapted from a form used by the Office of the Ombudsman, Center for Cooperative Resolution, NIH.

Case Studies

It's Working: Case Study 16

A new initiative included team members who were steeped in tradition and knew how the system works, and others who were newer and willing to challenge the status quo. At the outset of their collaboration, they spent half a day outlining their expectations about how they would communicate, make decisions, and address any problems that might arise. In addition, they committed themselves to creating an atmosphere in which members of the team could safely raise any scientific questions they had. To that end, they established an informal set of ground rules to provide guidance for team discussions. Shortly after the collaboration began, they found that team members often chatted in the hallways in addition to participating in formal meetings. The combination of experiences and backgrounds contributed to an interesting, collegial atmosphere.

It's Not Working: Case Study 17

Dr. Donaldson, a junior scientist, was loyal to the person who hired him, not to the lab chief, Dr. Chu, who later became his supervisor. When Dr. Donaldson was unhappy about Dr. Chu, he turned to his previous boss. When Dr. Chu was unhappy with Dr. Donaldson, he turned to a superior outside of the lab for support or influence. This made Dr. Donaldson feel anxious and insecure about his place on the team. He began to feel isolated and less committed to the team's research. He vented his frustrations to a fellow junior scientist, who in turn told a friend of his. This created an environment where everyone felt vulnerable to other team members' gossip and where social dynamics began to affect the lab's productivity and scientific achievements.

Keeping a Positive Mood

A positive mood supports a team's flexibility and resilience. "A team with a strong positive mood will be hopeful about the future and grateful for what is going well today," wrote facilitators Marcia Hughes and James Bradford Terrell in *Team Emotional and Social Intelligence* (2009). Team members and leaders must also be sure, of course, to reality-test their optimistic ideas or they run the risk of unchecked expectations, leading to burnout.

The authors list seven key ingredients that contribute to a positive team mood:

- ✦ Positive, can-do attitude
- ✦ Hopefulness
- ✦ Curiosity

- ✦ Perseverance
- ✦ Attitude of abundance
- ✦ Playfulness
- ✦ Zest

To promote a positive mood among your team, try gathering team members in pairs or small groups to answer the following questions; then discuss responses as a large group:

- ✦ How do you demonstrate a positive attitude as a team?
- ✦ How do you demonstrate a long-term view and keep things in perspective?
- ✦ Are playfulness and a sense of zest encouraged in your team? If so, how?

Ask Yourself: Is It Working?

When It's Working

- Team members have regular opportunities to discuss issues in a safe environment.
- Team members feel they are valued and value others, creating an atmosphere of mutual support.
- Team members trust that problems will be addressed, rather than left unresolved.
- There is a shared understanding and set of expectations around how conflicts will be handled.
- Team members trust that decisions will be made using a fair process that includes an opportunity for comment.

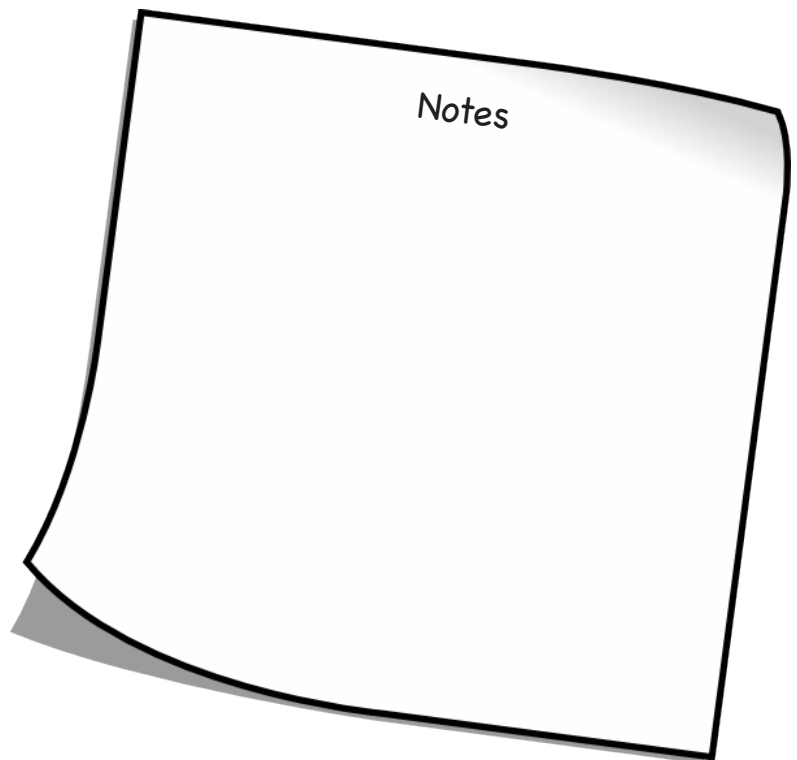
When It's Not Working

- An unpredictable, uncertain atmosphere leads to feelings of anxiety, vulnerability, and threat.
- Team members are uncomfortable discussing difficult issues as a group, contributing to indirect communication.
- Little sense of personal recognition or value among team members dampens the sense of ownership of team goals.
- Team members have insufficient or unequal commitments to team performance.
- Team members feel isolated, alienated, or defensive.
- Team members, including the team leader, do not provide honest feedback.
- Team members engage in gossip.

Take Aways

Positive team dynamics are a product of other effective team processes:

- Constructive and open communication
- Early intervention in problems and conflicts
- Shared recognition of each other's strengths
- Strong leadership
- Productive participation
- Interpersonal trust

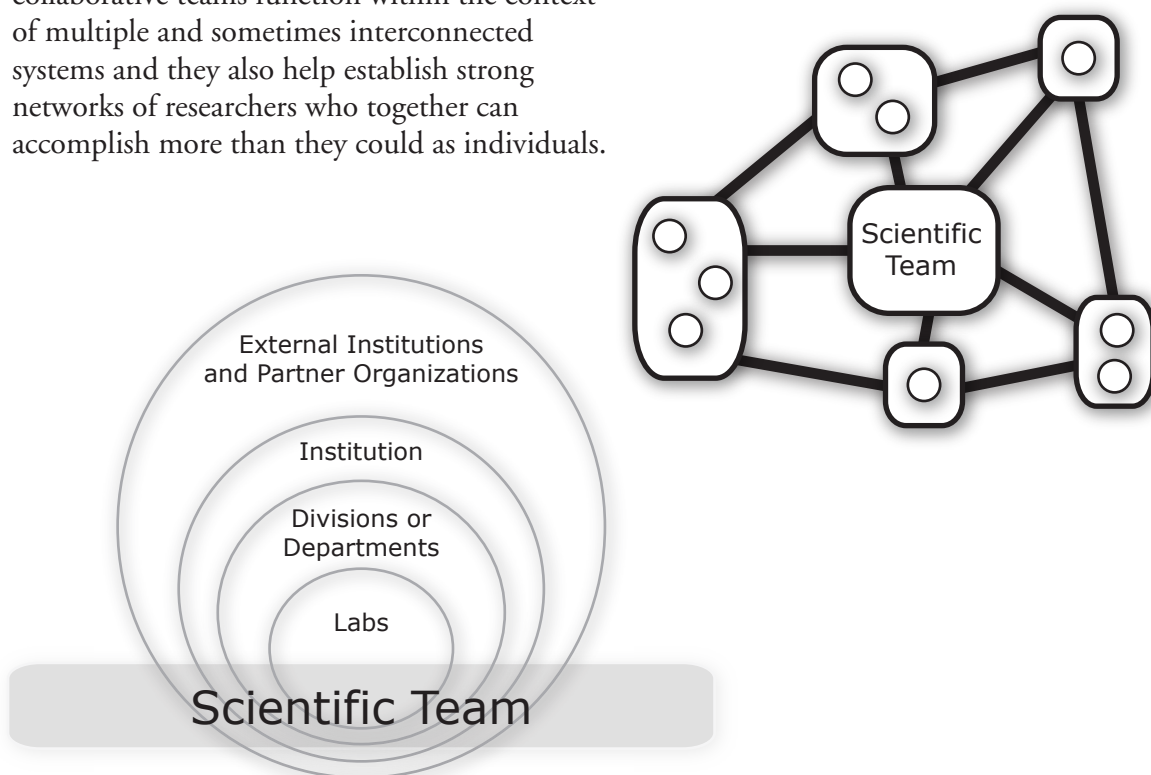


Navigating and Leveraging Networks and Systems

Highly collaborative teams frequently bring together people from different parts of the same division or department, from across an institution, or from myriad organizations and locations beyond the institution's walls. When people join or initiate research teams, they inevitably discover that they are operating within and across organizational boundaries. It can be a challenge to work across borders, even within the same scientific organization, when an institution's culture values work that is done largely independently and in isolation or does not have procedures or infrastructure in place to facilitate cross-organizational interactions. That says nothing of collaborating with others beyond the confines of the organization.

A research team could be visualized as the intersection of organizational entities that may or may not have their own points of interconnection. The team benefits from the expertise contributed by each of the component parts and, together, the components constitute an overall network or system within which the team operates. A research laboratory could be considered as its own focused system within the context of a larger system—the department or division—that, in turn, sits within and/or is influenced by a larger, more powerful system.

The simple diagrams below show how a team can transcend different organizational levels and extend its reach within and beyond the organization. A more complex representation would attempt to show the various interactions among investigators within and among institutions that contribute to the overall project. Once this is sketched out, it will look a lot like a network map, not unlike a protein map that is used to demonstrate the complexity of the system in which the protein is functioning. And so, we come to recognize that highly collaborative teams function within the context of multiple and sometimes interconnected systems and they also help establish strong networks of researchers who together can accomplish more than they could as individuals.



How to Navigate and Leverage Networks and Systems

- Ensure that processes and procedures are in place to robustly and rigorously review, recognize, and reward researchers involved in highly collaborative research teams.
- Communicate and demonstrate to those participating on and leading research teams that their efforts, if truly outstanding, will be appropriately rewarded.

If the community of researchers within an institution does not believe, or does not perceive, that team science is truly valued and rewarded at the same level as individual achievements, researchers' motivation to participate on research teams will be diminished.

Gaining an appreciation of these facts is important for researchers and their institutions. Indeed, it is imperative that leaders of research teams and the participants who are contributing understand the system in which they are doing their work. What do we mean by this? There are multiple systemic factors that contribute to successful team functioning. Among these is the support from the division or department leadership. Without support from the immediate organization, it will be difficult to generate and maintain momentum, secure funding from internal or outside sources, or ensure that processes and procedures are in place to recognize the contributions of many toward a common goal. It is not sufficient for the institution to express support for collaborative efforts and scientific teams. Institutions need to develop procedures and criteria for assessing the accomplishments and contributions of collective efforts of scientific teams, as well as of the individual members who contribute to those efforts. In addition, these assessments ought to be factored into the institutional decision-making processes by which the resources and support are allocated. NIH, for example, has striven to rework its criteria and metrics for tenure review in order to recognize and reward team science.* Such reassessments are critical because institutional support and recognition of the importance of these issues catalyze team approaches and the development of appropriate processes and procedures to support them.

Fortunately, the value of highly collaborative work is being recognized and encouraged by many organizations and at many levels of hierarchy. Unfortunately, there are still many tales of scientists and clinicians at prominent institutions who hear that working with multiple colleagues on complex scientific problems is valued, only to find out during a tenure review process or other evaluations that they are viewed as “not demonstrating the required independence” to make it to the next step in their career trajectory. In other words, promotion policies, institutional norms, and personal values of evaluation committee members are not always up to date with the messages being broadcast by organizational leadership; this can have a strong negative impact on those participating in team science.

For this reason, the ability of a research team's leader to engage positively with and gain the support of his or her organizational leadership cannot be understated. This is especially true in situations where institutional policies, procedures, and processes do not align with the organization's encouragement that investigators participate in team science. In this way,

* Guidelines are available at <http://www1.od.nih.gov/oir/sourcebook/prof-design/tenurecriteria.htm>.

the leader can put into place specific processes, if only for his or her special circumstance. For example, appropriate review and recognition of collaborative research efforts could be negotiated in a new recruit's start-up package.

The Team as a System: Social Network Analysis*

The social structure of a team will also impact how the group functions and how well it performs. Once teams have formed and begun working toward their goals, team members can map out their social network by performing a *social network analysis* (SNA). Merely having an organizational chart and a listing of the job responsibilities of each of the members of a research team will not necessarily give you a good picture of how a team actually works, who interacts with whom, or the impact on the team of each of its members.

An SNA can help you and other team members understand the interactions that are or are not taking place within and outside of the team. Within this context, team members can identify areas of strength or weakness and assess how valuable resources are utilized. The ultimate goal of this approach is to implement strategies to improve the team's ability to create and share knowledge by looking at how people interact.

An SNA can help a team answer the following questions:

- What systems have we put in place?
- Can we use our internal or external systems to more effectively get work done?
- How can those systems be modified or enhanced to better support the team's mission?

To perform an SNA, consider four types of networks: knowledge, access, source receptive, and energy (see inset box on page 54).

Case Studies

It's Working: Case Study 18

Dr. Felix had worked largely as a solo investigator for many years when he accepted a senior position on a research team investigating epitope-driven vaccines. Dr. Felix was pleasantly surprised by how supportive the institute was of the team's efforts, and how this was clearly communicated and demonstrated. They had recently revised certain policies that had not been "team science friendly" to encourage investigators to work collaboratively and ensure fair review at tenure meetings, annual performance evaluations, and other institutional venues. Mechanisms were put in place so that individuals would be regularly recognized for the outstanding research they were performing on their own as well as their contributions to meritorious team efforts. Dr. Felix's team leader had an excellent relationship with the institute's leadership, making the group, as a whole, feel supported in their efforts.

* See Bunker, Alban, & Lewicki, 2004, and Cross, Baker, & Parker, 2003, for additional information.

It's Not Working: Case Study 19

Dr. Amiel was recruited to a prestigious institute to begin her career as an independent investigator. She was recognized to be a creative thinker, had successfully challenged existing paradigms at the postdoctoral level, and had proposed a compelling line of research to pursue. In addition, her strong scientific contributions and leadership ability were clearly demonstrated in her work with a collaborative research team, an attribute the institutional leadership indicated was highly valued. Dr. Amiel quickly found her place at the new institution, initiated the independent research she proposed, and made substantive contributions as both a participant and a leader in collaborative research efforts. At her formal review three years later, Dr. Amiel was shocked at her overall assessment by the outside review team. She was praised for her independent research, but the review committee strongly suggested that she abandon her collaborative research projects because they “will not contribute to international reputation” and noted that “it is difficult to assess her independence” in the context of the collaborative work. The reviewers said the time Dr. Amiel was squandering on these efforts could be redirected to ensure that she attained tenure at her next review. Since there were no policies or criteria in place for the review of contributions to team research efforts, they were barely considered by the outside committee and provided no foundation for an appeal to the review.

SNA Networks

Four types of networks are described below. Asking the questions provided in italics can help you gain a better understanding of the components that comprise each network.

Knowledge Network: Knowing who can answer questions or provide more information allows for more efficient functioning and points the team in the right direction to obtain the information it needs. Effective teams build in some redundancy here so that the team does not come to a halt if a key person in the knowledge network suddenly becomes ill or unavailable.

Ask: *Who does or does not have the specific information I need?*

Access Network: One may know where to go for information, but a critical question is whether the person with the information will share it and be a resource for additional information.

Ask: *I've identified who has the information, and will he or she share it now and in the future?*

Source Receptive Network: Within teams, the old adage “knowledge is power” sometimes points to an ugly reality: team members are not always collaborative. If there is personal enmity between two team members, or if trust is low, they might withhold data, materials, or technical assistance.

Ask: *Will I be welcomed as a collaborator? Will he or she share with me the data and resources I'm looking for?*

Energy Network: The outcome of the above interactions may impact the energy of team members and the group as a whole. Energy can propel a team forward and support its functioning; likewise, drains on energy can sap momentum. Key people and interactions that infuse energy into the team or suck it away should be quickly identified. Not surprisingly, energized teams perform better when the group is focused on a positive goal and when the members are fully engaged, feel they are valued, and sense that they are contributing to the overall progress toward the stated objectives. Every team member—from team leader to research assistant—plays an important role in a team's energy and team functioning.

Ask: *How did my interactions with him or her feel? Did it give or take from the team's energy?*

Ask Yourself: Is It Working?

When It's Working

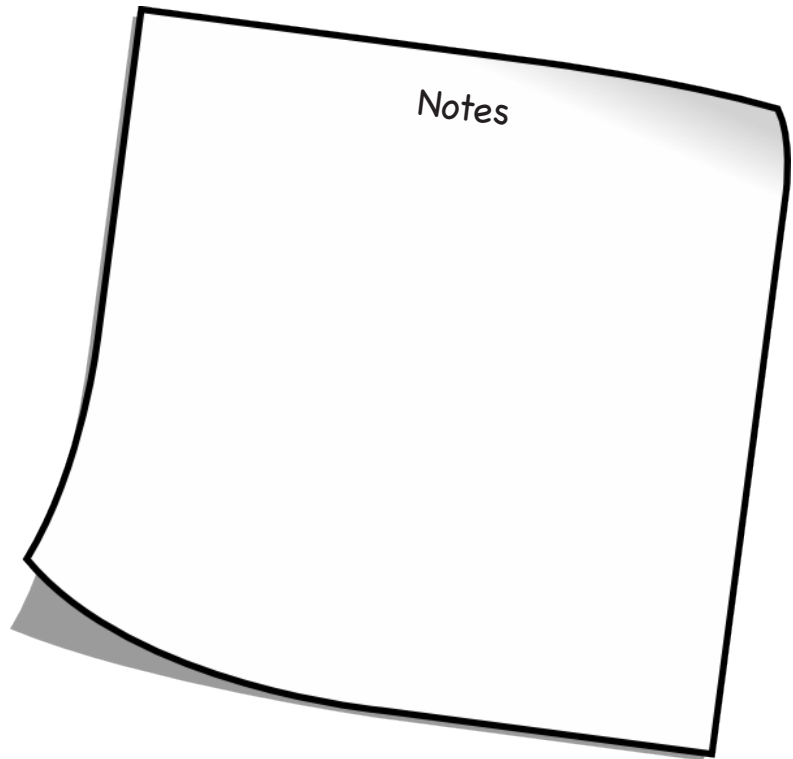
- Team leaders are aware of immediate and overall institutional support.
- Team leaders and team members work to secure support and recognition of the team as a unit as well as individual contributions to the team.
- Teams thrive when there is top-down support and bottom-up vision and enthusiasm.
- Perceptions that the institution is unsupportive, while frustrating, do not stand in the way of the leader doing what he or she thinks is right.
- Teams cut across boundaries and have distinct patterns of communication, information exchange, informal influence, and trust.
- Teams establish formal and informal networks that facilitate research progress.
- Team leaders take the time to understand social networks.

When It's Not Working

- Junior scientists and clinicians are wary of entering into complex collaborations for fear that their institutions will not recognize their contributions during review.
- Team leaders and members are unsure whether their work on a team will help, or hinder, their careers.
- There is confusion over the team's place in the organizational structure.
- Organizational leaders do not consider teams as they develop strategic plans, budgets, and other institutional policies.
- The team is unable to establish connections as a group with key individuals or groups within the organization.
- The team encounters resistance, obstruction, or complacency when it interacts with other institutional bodies.

Take Aways

- All teams function within larger systems that have an impact on how the team operates.
- Team leaders must have a holistic view of where the team sits in the institution as well as key players who influence the team's functioning.
- Team leaders must seek institutional support for their efforts from individuals at the highest levels.



In the course of this *Field Guide* we have laid out some of the criteria that contribute to the robust execution of collaborative and team research activities. At the same time, we must recognize that there are many challenges and hurdles that can slow, delay, or even prevent a collaborative effort from succeeding. Finding ways to address these challenges often sets the groundwork for building a successful team. Just as each research team has its own recipe for success, each team finds ways to face and manage challenges.

Although the personal and interpersonal dynamics of team functioning are the most obvious challenges that face the team, those imposed by institutions are among the most difficult to overcome. Making changes in policies, procedures, and criteria that have been in place for decades takes hard work, persuasion, negotiation, and lots of meetings. While institutions may encourage the idea of team science, they seem to be extremely resistant to making changes to the system to truly facilitate it and foster successful outcomes.

Recognition, Review, and Reward

Centrally important to supporting team science is the development of appropriate processes for recognition, review, and reward of collaborative scientific work. Engagement in and opportunities for collaborative interactions are abundant given that it is necessary for multiple areas of expertise to be represented in order to make research advances. However, the same institutions that promote the idea of research collaborations and are eager for the visibility and funding that go along with such efforts may not necessarily support them at the institutional level.

Although there is much talk in institutions about team science, its importance is rarely translated into the institutional structures within which science exists. First, consider research facilities themselves. While there are some notable exceptions, most are built along the model of a “research motel,” with separate laboratories laid out in a way that minimizes interaction among the inhabitants within each lab. Even when we look at the typical design of a scientist’s laboratory we notice that it revolves around the individual. As a scientist becomes more successful, he or she needs more lab space to hire junior investigators. For the junior scientists, career growth dictates that they need to eventually leave the laboratory and establish their own labs in order to be recognized as taking a successful step up the ladder. Career paths in the biomedical sciences that support a vision of science focused on collaborative efforts have yet to be defined. When a research scientist joins a team, it is typically under a lead investigator and with limited resources and independence. For collaborative research teams that exist within an institution, the commitment of space by the institution to the team would be a strong demonstration of recognition and support. Some team efforts could be greatly enhanced through co-localization of key members of the team. And, of course, the construction of new research facilities ought to incorporate the needs of scientific collaboration into its very design.

Parallel to the limited recognition of team science is the lack of hiring and promotion mechanisms to support team science in the biomedical sciences. There is a tremendous need for a promotion structure to support the career development of those participating on highly collaborative teams. The creation of such mechanisms would signal institutional commitment to the community.

Many institutions have yet to establish mechanisms to review or give credit for team science and complex collaborations. For the most part, reward systems are focused on individual accomplishments. Routine criteria regarding team science for review panels, metrics or milestones for the researcher involved in collaborative work, and policies and procedures to ensure that young investigators are not punished for participating in collaborative teams are lacking.

Likewise, the reward structure tends to focus on individual achievement and accomplishment while downplaying the contributions of colleagues with whom a scientist conducts his or her research. Often, one team member is nominated for and accepts awards for research performed by the team, is asked to give presentations or preside over panel discussions, or is invited to participate in a media interview. In spite of some recognition that there are multiple people involved, one individual—perhaps the scientist perceived to be the leader—is the recipient of the reward.

The development of appropriate approaches for reviewing teams, as well as criteria for evaluating the scientific achievement and accomplishments of the team as a whole and for rewarding the team for the work performed, is critical. Institutions have an obligation to institute policies and procedures for recognizing, reviewing, and rewarding the team science and collaboration they are encouraging.

Catch-22 for the Tenure-Track Scientist

One question surfaces in every tenure committee meeting: “Has Scientist X demonstrated independence?” For tenure track investigators to be awarded tenure, they need to not only do outstanding science, but also to demonstrate their independence. As a result, early-career, energetic researchers are typically cautioned against collaboration and counseled to focus exclusively on independent efforts. After many years of research successes achieved through individual effort, they are, once tenured, allowed and perhaps even expected to collaborate and join with others to solve complex scientific problems.

Systems, policies, and criteria need to be put in place to assure early-career investigators that they can participate on collaborative research teams and that they will be appropriately reviewed and rewarded during the tenure process for doing outstanding science as part of collaborative interactions.

Sharing and Giving Credit

Institutes have trouble giving an individual credit for a scientific accomplishment if credit for the achievement was shared among multiple people. There is a belief among many established researchers involved in team science or highly collaborative work that there comes a time in their careers when they should cede senior authorship on papers and pass speaking invitations to more junior members of the team so that the junior members can attain greater recognition, take a more prominent role, and further develop their careers. Review teams that value the individual investigator grapple mightily with how to deal with such situations. There can be the misperception that the senior investigator is no longer playing an important role; why otherwise would she or he give up the last author position or not give the talk? Culture shifts in how sharing and giving credit are perceived will be another critical element to ensuring that there is enthusiasm for participating in collaborative ventures.

What happens when two team collaborators at roughly the same career development stage aspire to the same progression of promotions? While science is inherently competitive—and needs to remain so to ensure the most robust research approaches and outcomes—does it make sense to promote just one of two equally outstanding scientists purely based on the premise that it has always been done that way and no mechanisms are in place to support the promotion of both?

Training in Collaborative Research and Team Science

We hear articulated over and over again the need for more training in collaboration and team science. There is a strong perception among many senior researchers and the leadership of biomedical institutions that people are not provided with the information or introduced to the skill sets that can help them to establish and maintain strong collaborative relationships.

This Is Pretty Obvious Stuff

In our experience it has not been unusual for people to characterize the principles, ideas, and concepts presented in this manual as pretty fundamental—you know, they're just common sense; they're obvious. They may also be perceived as fluffy or mushy. Some may feel the concepts are difficult to get one's head around, especially since there are no concrete data or experiments that can be performed to prove anything, and there is no one formula that ensures success.

While much of this may seem obvious, a real disconnect exists when we consider many people who are engaged in scientific and personal interactions. For example, while people intuitively know that trust is a strong foundation for collaboration, their behavior during everyday interactions with group members in the laboratory, during seminars, or when discussing data sometimes sends a strong message of lack of trust. The individual may self-assess as a very trusting person and someone who can easily build trust with others; however, real-life experiences indicate the exact opposite.

We devoted a module in this *Field Guide* to self-awareness because willingness not only to self-examine but to accept and act on feedback from others can greatly enhance one's ability to align his or her self-perception with reality, and even change one's behavior (see *Preparing Yourself for Team Science* on page 5).

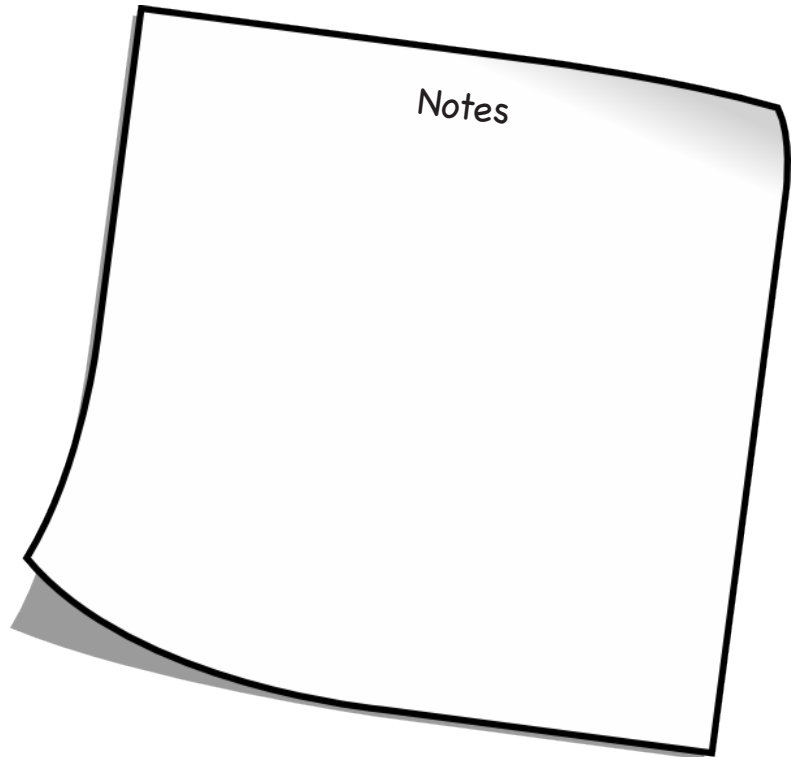
Change Is Not Easy

Change is not easy, especially when it involves buy-in and implementation at numerous institutions. It requires a lot of work and investment in new ways of thinking about and doing things. Perhaps the greatest challenge in any change process is the resistance encountered. Regardless of how great an idea someone has or how much sense the new approach makes, the change agent will encounter resistance. For some, change is disruptive and implies a loss of control; for others, it is an opportunity to improve and move to a new level.

Challenges

Change is really a cyclical process. We are in constant cycles of change, and recognizing how change can emerge from resistance will reduce the hesitation surrounding it. A cyclical series of steps associated with overcoming resistance and moving through change includes:^{*}

- **Recognition:** Events occur that bring attention to a problem, issue, or opportunity that would benefit from being addressed.
- **Initial Action:** Enthusiasm builds around doing something. Building awareness among stakeholders is critical.
- **Implementation:** Initial plans for change are articulated and feedback is sought from the community and those with a vested interest.
- **Integration:** The agreed-upon solution to the challenge, problem, issue, or opportunity becomes part of the overall process of how work is accomplished.
- **Waning Activity:** Some new factor comes into play or new ideas or opportunities emerge, signaling it is once again time to start the cycle and pay attention to—or recognize—things that should be changed in order to make things work better.



^{*} For a more detailed discussion of this process, see *Beyond the Wall of Resistance*, by Rick Maurer (1996).

How many times we have heard or even told students at a career fair, “If you do what you love, you will love what you do.” It sounds so trite, so simplistic, and yet there is something about that phrase that people enjoy holding onto.

When thinking about this in the context of the laboratory and a great collaboration, what is the driving force behind this commitment to solve a research question together? This is where passion comes in. We have used the words *commitment*, *vision*, and *mentorship*—all of which are vitally important, and all derive from an inner passion and a relentless curiosity. What could be more fun and more satisfying than finding other people with similar passions and interests with whom to unravel complexities and make new discoveries?

It is not just successful scientific problem solving and discovery that lead scientists to work collaboratively. Although it is not often discussed, one of the most compelling aspects of collaborative work is that it is fun. Anyone who visits a highly cohesive laboratory quickly notices that people work well together, there is a welcoming and enthusiastic environment, and the lab members are clearly comfortable working with each other. In informal discussions with scientists, they often refer to having fun and point to the satisfaction that comes from being part of a team that works well together. Daniel Kahneman, the psychologist who won the Nobel Prize in economics, describes the delight he discovered in his collaboration with Amos Tversky:

“[W]e met in Jerusalem to look at the results and write a paper. The experience was magical. I had enjoyed collaborative work before, but this was different. Amos was often described by people who knew him as the smartest person they knew. He was also very funny, with an endless supply of jokes appropriate to every nuance of a situation. In his presence, I became funny as well, and the result was that we could spend hours of solid work in continuous mirth . . . [A]nd we were not just having fun. I quickly discovered that Amos had a remedy for everything I found difficult about writing. With him movement was always forward . . . [A]s we were writing our first paper, I was conscious of how much better it was than the more hesitant piece I would have written by myself” (American Psychologist, 2003).

Kahneman’s remarks point to many of the best things that research collaborations can offer: complementarity in styles and abilities, enhanced quality of the final product, a deeply satisfying connection to a colleague, and substantial doses of fun.

Interestingly, recent research in the relatively new area of positive psychology supports these informal observations. In a wide variety of settings there are very strong correlations between people’s happiness in their work and their commitment to that work, their relationships with colleagues, and productivity.

More broadly, there is also research demonstrating the adaptive value of positive affect. “Beyond their pleasant subjective feel, positive emotions, positive mood, and positive sentiments carry multiple, interrelated benefits” (Fredrickson & Losada, 2005). These benefits are both behavioral and physical. Among the noteworthy behavioral benefits of positive affect are an expanded scope of attention, increased creativity and intuition, and broadened behavioral repertoires.

We hope you have found the *Field Guide* useful and that you will refer back to it as you begin or continue to take part in team science. After reading it, you should now be more prepared to:

- Ask for a collaborative agreement, even if your collaborator is a good friend.
- Give—and receive—feedback.
- Put “tensions” out on the table for discussion and follow through calmly and in control of emotions.
- Write your own vision statement and compare it to that of your supervisor and/or team members.
- Face conflict with confidence that you can come to a positive resolution.
- Establish trust with your colleagues—you may develop lifelong, valuable relationships.
- Put the effort into establishing a team—it takes time and energy, but it pays off in the long run!

We encourage you to get out there and test your new team science skills and continually think of ways you could become a better team player. And don't forget to have some fun!

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Appendix: Collaborative Agreement Template

Although each research project has unique features, certain core issues are common to most of them and can be addressed by collaborators posing the following questions:

Overall Goals

- What are the scientific issues, goals, and anticipated outcomes or products of the collaboration?
- When is the project over?

Who Will Do What?

- What are the expected contributions of each participant?
- Who will write any progress reports and final reports?
- How and by whom will personnel decisions be made? How and by whom will personnel be supervised?
- How and by whom will data be managed? How will access to data be managed? How will you handle long-term storage and access to data after the project is complete?

Authorship, Credit

- What will be the criteria and the process for assigning authorship and credit?
- How will credit be attributed to each collaborator's institution for public presentations, abstracts, and written articles?
- How and by whom will public presentations be made?
- How and by whom will media inquiries be handled?
- When and how will you handle intellectual property and patent applications?

Contingencies and Communicating

- What will be your mechanism for routine communications among members of the research team (to ensure that all appropriate members of the team are kept fully informed of relevant issues)?
- How will you decide about redirecting the research agenda as discoveries are made?

- How will you negotiate the development of new collaborations and spin-off projects, if any?
- Should one of the principals of the research team move to another institution or leave the project, how will you handle data, specimens, lab books, and authorship and credit?

Conflict of Interest

- How will you identify potential conflicts of interest among collaborators?
- Could a collaborator or any close family members or associates benefit financially from the research?
- Is a collaborator receiving money from someone who could benefit financially from the research?

Examples of conflicts can be found at: <http://ethics.od.nih.gov/procedures/COI-Protocol-Review-Guide.pdf>.*

* A collaborative agreement does not take the place of Material Transfer Agreements (MTAs), Cooperative Research and Development Agreements (CRADAs), or other documents that may be institutionally required.

