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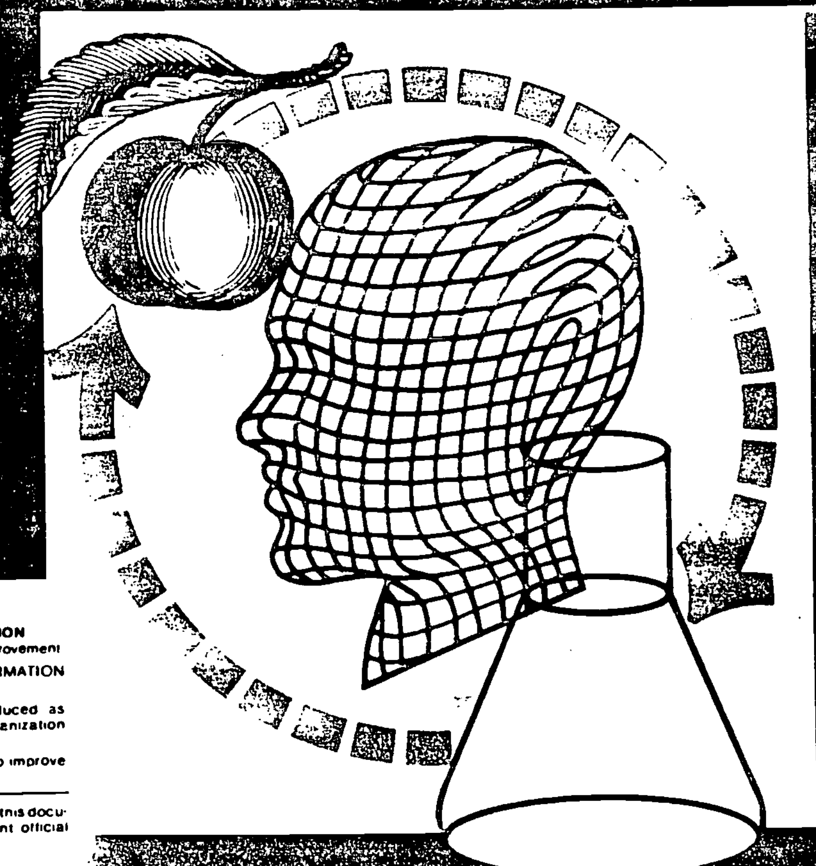
ABSTRACT

This guide stems from concern that many classroom teachers have limited exposure to the scientific community in general and to the nature and method of science in particular. It offers guidelines and suggestions to plan, conduct, and evaluate summer mentorship programs and gives practical advice on establishing programs, garnering institutional support, soliciting financial support, engaging participating partners, and fostering productive teacher-mentor relationships. The information presented here has been culled from the experiences and insights of other program planners and teachers who have actually participated in fellowship programs. Chapters include: (1) "Planning and Evaluating Programs"; (2) "Roles of Host Institution, Mentor, and Teacher"; and (3) "Development of Instructional Materials". Appendices contain an application for a summer fellowship program and post-program surveys of teachers and mentors. (JRH)

FROM THE LAB BENCH TO THE CLASSROOM:



A Program Planner's Guide To Developing Summer Fellowships For Classroom Science Teachers

NATIONAL INSTITUTES OF HEALTH
National Institute of Mental Health

CONTENTS

It is, in fact, nothing short of a miracle
that the modern methods of instruction have
not yet entirely strangled the holy curiosity of inquiry;
for this delicate little plant, aside from stimulation,
stands mainly in need of freedom;
without this it goes to wrack and ruin without fail.
It is a very grave mistake to think that the
enjoyment of seeing and searching
can be promoted by means of coercion
and a sense of duty. To the contrary, I believe
that it would be possible to rob even a healthy
beast of prey of its voraciousness, if it were possible,
with the aid of whip, to force the beast
to devour continuously, even when not hungry,
especially if the food, handed out under
such coercion, were to be selected accordingly.

ALBERT EINSTEIN

4

INTRODUCTION

America 2000 is an education strategy that sets national goals for improving education. National Education Goal 4 calls for American students to rank first in the world in mathematics and science achievement by the year 2000. If students are to better their performance, teachers must also.

One clear and direct way academic institutions can improve the quality of classroom science teaching is to offer summer fellowships to science teachers. Many professional societies, colleges and universities, private businesses, and government agencies currently offer summer mentoring programs designed to provide teachers with rich and diverse lab experiences. Fellowships give teachers opportunities to work in labs, to talk to scientists and researchers, and to conduct research projects. These experiences enrich a teacher's understanding of the nature and method of science. Such experiences may supplement a teacher's knowledge of a particular scientific discipline. When such lab experiences are directed by a dedicated mentor — usually a research scientist — the experience becomes invaluable: The mentor helps the teacher to integrate the work of the lab into his or her teaching.

This offers guidelines and suggestions to plan, conduct, and evaluate summer mentorship programs. It gives practical advice on establishing programs, garnering institutional support, soliciting financial support, engaging participating partners, and fostering productive teacher-mentor relationships. The information presented here has been culled from the experiences and insights of other program planners and teachers who have actually participated in fellowship programs.

This guide stems from concern that many classroom teachers have limited exposure to the scientific community in general and to the nature and method of science in particular. This lack of exposure in teacher education and continuing education has affected the quality of science education in the United States. The scientific and educational communities need a tangible, practical way to address and counterbalance this problem. This guide and the programs it encourages are designed to provide a step in the right direction.

By encouraging the direct involvement of the scientific community in the continuing education of science teachers, the scientific community will become even more influential in educating *students*. The nation's students, after all, will be scientists, engineers, researchers, lab technicians, consumers, and policymakers in the future. The scientific community has an opportunity, then, to influence the science and mathematics education at the elementary and secondary levels.

Mentoring programs offer teachers an experience similar to apprenticeships and continuing education opportunities other professionals enjoy. Much as doctors serve as residents and lawyers as judicial clerks, science teachers working with mentors learn first-hand about the professional lives of scientists and the workings of a lab. In the same way that college and university professors take sabbaticals where they may conduct independent research projects, teachers in fellowship programs willingly engage in new learning opportunities.

Mentoring programs are also an opportunity for the scientific community to learn more about the direction of science education and to influence teaching in scientific disciplines. If the schools are to keep pace with the changing course of research and the proliferation of scientific knowledge, they must expand their programs and improve their curricula. Scientists can help schools meet this challenge.

For teachers and mentors, as well as for host institutions, summer fellowships offer a view into each other's world. Teachers learn about the day-to-day activity of the research lab. Scientists learn about the realities of teaching science and about the challenges and rewards teachers find in working with students. All partners benefit from this exchange of knowledge and experience, and ultimately, students will benefit. By being scientifically literate, students will be able to make informed decisions about many of the questions and issues they will face as they grow older. Some may eventually enter scientific careers themselves. These rewards alone are a great return on institutional investments in fellowship programs. Science can reap these rewards if the scientific community cooperates fully and enthusiastically in the improvement of elementary and secondary school science curricula.

6

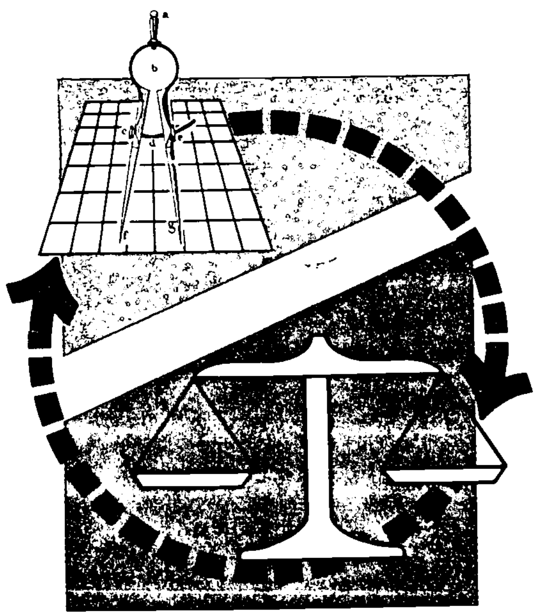
1. PLANNING AND EVALUATING PROGRAMS

Organizations and institutions that have sponsored successful summer fellowship programs for classroom science teachers know that early and thoughtful planning is essential. *Planning* includes four basic steps:

- **Defining** the program's objectives and scope;
- **Identifying** partners such as lead groups, private and public sector organizations, and mentors, and assigning specific responsibilities to each;
- **Establishing** both a process for recruitment of teachers and mentors and the criteria for their selection;
- **Seeking** funding.

Another element of program planning is developing *evaluation criteria.* Even before a program begins, institutions must decide how to evaluate:

- The teachers' performance
- The mentors' performance
- The appropriateness of the lab experience
- The performance of the *entire* program.



PROGRAM PLANNING

Define Objectives

The first step in planning a program is to define its objectives. Goals can range from improving institutional relations with local school districts to improving the science curriculum in a specific school. Whatever your institution's objectives, they must be clearly defined from the outset. Does the institution's mandate include a general commitment to improving and promoting science education? Does your institution want to strengthen its community ties by supporting and improving science education in area schools? Do you want to focus on individual teachers only or on improving the teaching of science in an entire school or district? Is your institution interested in a hands-on approach, perhaps helping to develop science curricula? Is your staff eager to serve as mentors to classroom science teachers?

An example of clearly defined objectives for a program involving secondary school teachers might include the following:

- Involving high school and middle school teachers in active science labs;
- Changing the emphasis and improving the quality of science taught in the high school and middle school science curriculum;

- Developing instructional materials for use in high school classrooms;
- Testing a model for developing curriculum using a telecommunications network;
- Collecting information that will help expand the program to other locations.

Institutions may change their program's objectives over time as programs evolve. By establishing objectives and goals early, however, program planners give themselves and participants a structure within which to work effectively. They automatically create the framework for program evaluation that is critical for improving programs in subsequent years.

When setting objectives, program planners should consider their program's scope and schedule. Planners must decide, for example, how many teachers can participate. This number will vary according to a program's budget, facilities, and the availability of suitable mentors.

Institutions should consider the duration of the program, a decision that determines, to some extent, the nature of the fellowship. Programs must last at least six weeks if they are to have worthwhile accomplishments. Some organizations have found that a

Program Planning Timeline

6 months before fellowships begin

☐ Send information and applications to teacher pool

5 months

☐ Review applications and select qualified applicants

4 months

☐ Conduct personal interviews with applicants and select final fellowship participants

☐ Send letters of acceptance to selected teachers; letters of regret to those not selected; letters of thanks to all who assisted in selection process

☐ Notify mentors of selections and begin pairing teachers and mentors

3 months

☐ Schedule orientation for teachers (at least one month before fellowship begins) and notify teachers and mentors

☐ Send letters to mentors outlining duties and responsibilities and encouraging them to contact and visit teachers

☐ Send letters to teachers describing duties and responsibilities

1 month

☐ Conduct teacher orientation, usually for one-half day or full-day

☐ Encourage teachers and mentors to meet in labs

Summer fellowship session begins

Weekly

☐ Conduct meetings with teachers and mentors to review progress

Mid-session

☐ Conduct mid-course review and make appropriate revisions

Conclusion

☐ Conduct oral and written surveys of teachers and mentors

December of that year

☐ Follow-up meeting with teachers to learn how they have applied lab experience to classroom practices

☐ Ask teachers to complete a survey discussing the effect of the program on their teaching

☐ Review implementation of instructional materials developed by teachers two-year mentorship program offers advantages that a one-year program cannot; teachers in two-year programs may feel that they learn or accomplish more, primarily because they have *time* to do so. A two-year program enables participants to become familiar with the lab and with the research environment. Teachers become more comfortable in the lab. They are able to build on the previous year's experiences. They may conduct more sophisticated research projects or master more complex lab skills. In such programs, second-year participants may serve as mentors to first-year participants. This kind of relationship offers teachers an even greater sense of mastery, while easing the level of commitment required by the institution's staff. However, applicants who cannot make a long-range commitment to a program may find the two-year requirement a barrier to participation.

On the other hand, one-year fellowships offer other benefits that two-year programs cannot. A greater number of teachers can participate. In turn, a greater number of schools and students are reached. However, one-year programs confront many time constraints that often cause teachers and mentors to feel they have accomplished less than they had envisioned. To avoid this, realistic goals and objectives are essential.

Regardless of the kind of program offered, program planners should be mindful of practical considerations (such as summer holidays, opening and closing dates for schools, or other significant institutional commitments) that may affect a program's schedule. Program planners should try to develop a detailed timeline, similar to the one shown on page 6.

Identify Partners

Although one institution or organization may conceive a program and act as the lead institution, several organizations eventually will be involved in developing, promoting, supporting, and conducting it. Once clear objectives are set, program planners at the lead institution must identify and recruit partners. Once partners actually have "signed on," they should receive clear instructions about their roles and responsibilities.

Program planners should be imaginative and far-reaching in enlisting support from diverse organizations. Many organizations may seem, on the surface, not to have a stake in improving science education. In reality, the *quality* of science education affects all of society, from government to business and industry, from academia to the marketplace. Thus, institutions should seek support from a broad base of organizations. A range of groups can contribute to a program's success, providing everything from funding to personnel, from mailing lists to facilities, from professional advice to resource materials.

Professional societies, two- and four-year colleges and universities, and federal, state, and municipal government agencies, often serve as *lead groups*. Professional societies may include scientific societies, such as the Society for Neuroscience or the American Society for Human Genetics, as well as those that support teachers, such as the National Association of Biology Teachers or the National Science Teachers Association. Lead groups are primarily responsible for setting program policies and objectives, obtaining and allocating funding, and supporting development of instructional materials (if the latter is a component of the program).

Business and industry as well as various philanthropic groups can join the program as *private-sector partners*. These partners may share the responsibilities of the lead organizations. Because these organizations develop budgets and plan far in advance, host institutions should solicit private-sector support at least two years before a program actually is scheduled to begin.

Mentors should be involved in the early planning stages of a program. They may offer insight and direction in the development of program objectives, identify sources of support, and recruit or encourage other staff to participate, promoting the value of mentorship throughout the host institution.

Establish Application Process and Selection Criteria for Mentors and Teachers

Mentors. Once a program's scope and schedule are established, the host institution should recruit mentors. It should establish an application process for teachers, as well as a mechanism for selecting teachers and pairing them with mentors.

When recruiting mentors, program planners should clearly explain the responsibilities that mentorship entails, especially the commitment of time, energy, and resources. Mentors may have to visit teachers' schools, instruct teachers in current lab procedures, and offer facilities in which teachers can conduct research. Program planners should emphasize the personal and professional benefits of mentorship — the satisfaction of guiding others, the sense that one has repaid one's own mentors, the intrinsic value of the mentorship program, and its importance for science education.

Mentors must be dedicated to provide teachers meaningful lab experiences that, in turn, will enrich students' experiences in the science classroom. The mentor must know that the teacher is not simply a hired hand, but a professional seeking career enhancement. Mentors should be curious about the world and work of classroom science teachers, taking time to visit classrooms and meet teachers and students. In doing so, mentors will better understand the direction and support that teachers need in the lab. They will also come to appreciate the challenges today's science teachers face.

Mentors must be willing to develop and support a research experience appropriate for a teacher within the context of the fellowship program. In many programs, teachers will have commitments that go beyond the lab, such as attending institutional seminars or developing instructional materials for the classroom. In addition, the project must be something that can be accomplished within a limited period, often as little as six weeks. Often, the project must have an element that can be adopted and transformed for classroom use.

While doing all of this, mentors must integrate the teacher into the life of the lab. Teachers should be included in all lab activities, such as weekly science meetings. Teachers should be introduced to lab staff and become familiar with the workings of the entire lab, not just one small component — or corner — of it. The teachers should have the "big picture" of the lab's work and the context of his or her own contributions to that work.

Sample Application

Applications can be complex or simple. Regardless of their length or complexity, applications should solicit information necessary to select teachers for fellowships and to pair them with mentors. A sample application is included in the Appendix.

Mentors should assist the teacher in developing appropriate instructional materials. Mentors usually are asked to review the materials, to assist in field-testing them (especially by providing materials and supplies), and to provide guidance for revision.

Teachers. While all of this work is being done with mentors, the teacher recruitment and application process also must begin. Development of criteria for teacher evaluation and selection should be inherent to this process.

The original application should describe the program expectations for and individual responsibilities of the participating teachers. The purpose of the program is to improve science education; teachers are responsible for taking advantage of the intensive summer lab experiences to achieve that goal. Teachers are expected to meet with mentors several weeks before the summer program begins to identify appropriate projects; teachers must take responsibility for designing their projects, however, and not expect the scientists to design individual "lesson plans" for them. Teachers are expected to spend the equivalent of eight weeks (approximately 320 hours) engaged in lab activities; teachers are responsible for coordinating schedules with their mentors that use the full amount of time. Teachers are expected to develop collegial, working relationships with scientists and technicians in the lab; teachers are responsible for initiating relationships with science professionals. Teachers are expected to translate their summer experiences into positive classroom experiences for students; teachers are responsible for developing and using curriculum materials that reflect applications of the newly acquired skills and knowledge. Only by thoroughly understanding the expectations and philosophy of the summer fellowship program can teachers make the commitments necessary to ensure the desired outcomes.

By participating in a research project, teachers will be expected to learn and understand what it means to work within a scientific discipline, learning new lab techniques as well as becoming current within a particular body of knowledge. Teachers have an opportunity to participate in the excitement of discovery or the frustration of pursuing some elusive result. The research experience should also be a chance for the teacher to reflect on ways in which the process of science can be incorporated into the teaching of science.

Program planners have many avenues through which to recruit teachers. *Tap all potential resources.* Send announcements to: public, private, parochial, and alternative schools; science coordinators; national, state, and local teacher associations; local boards of education; and school principals and administrators. Distribute announcements at local and regional programs, such as teacher in-service programs. Distribute announcements at state and national teacher conventions. Advertise in publications whose readership includes teachers, such as *The Science Teacher* and *NSTA Reports* (National Science Teachers Association), *American Biology Teacher* and *NABT News and Views* (National Association of Biology Teachers), *Science Education News* (American Academy for the Advancement of Science), and newsletters from state science supervisors or state affiliates of national teacher groups.

Planners often rely on a three-step application process:

- Written application
- Personal interviews
- Lab visits to meet mentors.

This process not only identifies qualified participants, it also serves as a mechanism for pairing teachers and mentors, ensuring the best possible matches.

The written application can be brief or extensive; successful programs have relied on both. A sample application appears in the Appendix. Most programs ask applicants to submit a resume, a description of their current work, and an essay discussing reasons for applying. Teachers often are asked to submit letters of recommendation and support from a supervisor and from colleagues.

Program planners may want to ask teachers for information about prior lab experience and technical skills. Although such information can be useful, it should not be limiting. Teachers who have limited lab experience can benefit from exposure to unfamiliar techniques. Regardless of teachers' educational attainment or scientific knowledge and acumen, they will come to the lab eager to learn new skills. Most teachers — even those with lab experience — will have to learn procedures and techniques peculiar to the lab.

The personal interview lets teachers and mentors meet, talk, and get to know each other. As with any interview, this process allows participants to learn whether or not they are well-suited and able to benefit from their association.

Finally, prospective participants often are asked to visit the host institution's labs and other facilities. During these visits, mentors can describe the work being done in the lab and discuss the environment of the research lab in general, and their lab in particular. Such visits reduce apprehension for all participants.

Ultimately, program planners must rely on their own judgment in selecting participants. If possible, however, program planners should seek the assistance and recommendations of curriculum supervisors from local school districts. These supervisors can describe a school district's curriculum in a particular subject, an insight that can be useful not only in selecting applicants, but in pairing teachers and mentors. Supervisors are familiar with an individual teacher's work and performance.

Program planners should pair teachers with mentors carefully and thoughtfully. Consider many variables, such as professional goals and achievements and personal interests and habits when making these assignments. When the teacher and mentor are well-matched — when they truly feel that they are peers — the working relationship tends to promote useful, valuable work. In some cases, pairing individuals who share common interests and hobbies strengthens working relationships.

Seek Funding

Program planners must be resourceful in seeking funding resources. As every grant applicant learns, the key to funding success is to apply early and often to all sources: Business and industry; federal, state, and local governments; philanthropic foundations; and professional societies should all be approached as potential funding sources.

Business and industry have become increasingly willing, and eager, to establish partnerships with nonprofit and public organizations whose goal is to improve the quality of science education.

Federal government agencies are obvious funding sources for education improvement projects. *State government* may also provide resources to such programs, especially through the Dwight D. Eisenhower Mathematics and Science Education State Grant Program. The Eisenhower Program is a federally funded project through which funds to improve science and mathematics instruction are distributed to state educational agencies and state agencies for higher education.

Philanthropic groups may make grants to fellowship programs. Local foundations may provide another source of funding.

Professional societies make grants to support summer fellowships and can provide other resources, such as access to the scientific community.

In requesting funding, host institutions should anticipate all possible expenses: the budget should be adequate to provide teacher stipends, to conduct additional administrative tasks, and to support the expense of having an additional staff member in the lab. Host institutions should consider including expenses associated with sponsoring seminars or symposia. The budget also should include funds for teachers to develop and test instructional materials if that is a component of the fellowship program.

PROGRAM EVALUATION

In planning a program, host institutions should consider how to evaluate it. Each program, indeed, each partner, will have its own measures of success. For teachers and school districts, the development of instructional materials may be a primary evaluation tool. For supporting foundations, the number of teachers who participate may be a critical measure, as well as indications of demonstrable change in teaching styles when the participants return to the classroom. For institutions, the effect of a teacher's presence in the lab may be a criterion. Increased institutional involvement in community education may be another. Teacher evaluations may provide mentors with insight for future mentoring relationships.

Several program evaluation mechanisms can be used during and after a fellowship program session:

- Throughout the summer, teachers can meet weekly to discuss their progress, especially if instructional materials are developed. This technique is most useful in programs that require teachers to develop instructional materials cooperatively. Teachers also can evaluate their mentors and their working relationships.

- Mid-course corrections help all participants — and the program itself — achieve their goals. Initial expectations for the research project may have been too great, or too limited, and can be revised. Teachers may need more or less support or guidance than mentors had anticipated. Resources may need to be allocated differently to accommodate unpredictable turns in scientific research.

Once a session or the summer has ended, other evaluation methods are helpful:

- Ask teachers and mentors to complete written surveys designed to evaluate the lab and mentorship experience in particular and the program in general. Sample surveys for teachers and mentors appear in Appendix B.

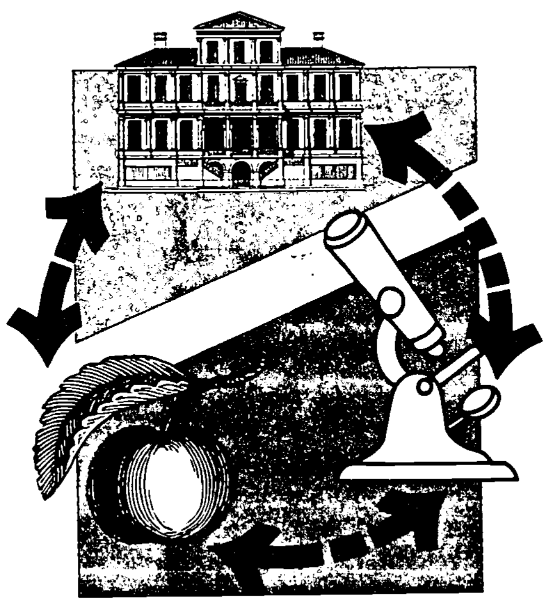
- Interview teachers and mentors to learn their opinions about the program, how they benefited from it, and how it might be improved for the coming year.

- Require teachers to attend a follow-up meeting at which they can discuss the effect of their lab experience on their teaching. How, for example, have they changed or improved science teaching in their own classrooms and school districts? How have their students and colleagues responded to these new approaches?

2. ROLES OF HOST INSTITUTION, MENTOR, AND TEACHER

In establishing summer fellowship programs for classroom science teachers, host institutions have a rare opportunity to shape and improve the ways in which U.S. students are exposed to science. But to do so, institutions must skillfully develop and support a relationship that may at first seem unusual: the science teacher as research fellow and the research scientist as the teacher's mentor. The research lab must become a classroom of sorts. The scientist must be willing to learn about science teaching, an area in which he or she may have little knowledge. The science teacher must be willing to become a student of advanced science, surrendering a certain element of control and routine to enter a working world that may be quite different from his or her own. In many ways, the fellowship program is a cultural exchange, where all parties learn and grow.

To make this exchange as productive as possible, host institutions must create a program where each participant has a clear and meaningful role. Although the mentor-teacher relationship may in some ways resemble a teacher-student relationship, with its attendant issues of authority, it should in fact be a professional relationship. Although the mentor and teacher are not on equal footing within the scientific community, each is a professional in a discipline that requires talent, expertise, knowledge, and devotion.



To promote beneficial, symbiotic relationships, host institutions should consider the roles to be played by each participant. By doing this *before* a fellowship summer begins, host institutions, mentors, and teachers can actually *spend* the summer accomplishing program objectives.

ROLE OF HOST INSTITUTION

The host institution must assume a variety of tasks: planning and initiating a program, completing routine paperwork, providing administrative support, and encouraging and sustaining support from the institution's staff and management.

Develop and Support the Program

The host institution is a liaison for research scientists and mentors, participating teachers, and the institution's own staff and administrators. The host institution is responsible for recruiting partners in business, industry, and government; seeking funding; and publicizing the fellowship to the education community. The host institution is primarily responsible for selecting applicants and pairing them with appropriate and suitable mentors.

Administrators in host institutions must encourage staff participation in the program, primarily as mentors. Mentors are volunteers who willingly give their time and resources. Even so, many institutions may have to motivate and offer encouragement, especially when beginning a new program. The host institution must tell staff about the value and worth of mentorship: the *personal satisfaction* to be gained, as well as the *societal benefits* that accrue from exposing science teachers to scientific research and lab work. Host institutions must *actively* and *persistently* seek and recruit mentors who can most benefit a program. This is especially true for institutions whose staff already feel overwhelmed by the pressures of research and other professional responsibilities.

Although mentors will be the most visible and active institutional participants, other staff at the institution and in the lab should be aware of and familiar with the fellowship program and its goals. Staff should be encouraged to meet and assist participating teachers and should be asked to open their labs and work areas to teachers, if only to provide teachers with a sense of the institution's purpose and the lab's role within the institution.

Perform Administrative Tasks

The host institution coordinates all administrative tasks associated with the fellowship program, from managing applications to administering and evaluating surveys. The institution also promotes communication among participants.

Once a program has been established and teachers and mentors selected, the host institution should send introductory letters to all participants. The letter to mentors should recommend that they visit the schools where teachers work. Invite mentors to attend the teacher-orientation session.

A similar introductory letter to teachers should discuss the institution's work, its mandate, and its place within the scientific community. Specify in detail the extent of the teacher's role and responsibilities. Highlight specifics about teacher orientation. Encourage teachers to contact their mentors and visit the institution before the actual fellowship session begins. Discuss various administrative issues, such as pay and parking.

Administrative issues for host institutions to consider include payment, insurance liability, teacher orientation, and graduate or in-service credit.

Payment. The stipend is generally a fixed amount that is linked to the teacher's regular salary. This connection reflects the institution's belief in the value of the work being done.

The institution also must decide how the stipend is to be paid: monthly, biweekly, weekly, or at the end of the program. Some programs pay participants half at the start of the program and the balance when a specific milestone has been reached, for example, when a survey has been completed or instructional materials have been fully developed.

Finally, for tax purposes, the institution must decide how the teacher is to be classified (as a regular employee, for example, or as a special hire or consultant). This classification often determines whether or not federal and state taxes are withheld from a teacher's pay. It often is easiest on teachers, many of whom are unfamiliar with self-employment tax regulations, if taxes are withheld from the stipend.

Insurance liability. The host institution should know the extent to which its insurance covers teachers in the lab. Generally, teachers have standard employee rights and responsibilities under such coverage.

Teacher orientation. The host institution should conduct an orientation program before the fellowship program begins. At this program, teachers should meet staff with whom they will work.

Have teachers complete all paperwork, such as confidentiality agreements and payroll forms. Resolve logistical issues, such as parking and access to the lab after hours. Issue parking passes and identification badges.

Give teachers a tour of the facilities, including the cafeteria, library, and labs. Ask appropriate institutional staff to make presentations. The institution's librarian, for example, might provide an overview of the library and its procedures.

Discuss and review general safety procedures for the institution's labs. Once the fellowship has begun, each lab should train teachers in its specific safety procedures.

Graduate or in-service credit. Host institutions should work closely and cooperatively with state and local school districts to ensure that teachers receive graduate or in-service training credits. Such an alliance may validate the fellowship program as a teacher-training tool, giving it credibility in the education community. By awarding credit, the program offers teachers a great incentive to participate.

Sponsor Seminars for Teachers

The host institution may sponsor a series of seminars or lectures. Such seminars often feature researchers from the institution's departments or labs, as well as guest speakers such as visiting scientists. Such presentations will give teachers a look at the variety of work supported by the host institution and the range and kind of work done by the institution's scientists. The program can be as informal as a brown-bag lunch, or as formal as a day-long conference.

In planning seminars, take care not to overwhelm teachers by requiring them to spend so much time in seminars that they miss valuable time in the lab. The seminars should *balance* the teacher's lab experience, not *override* it.

ROLE OF THE MENTOR

As emissaries for the host institution and for a particular scientific discipline, mentors are the people most able to influence the success of a fellowship program. More than any other aspect of a program — research conducted, seminars attended, curricula developed — the mentoring relationship *makes* a fellowship program meaningful and worthwhile.

Mentors must be keenly aware of the importance of their role. The mentor should share experiences, finding threads to link the professional scientific world with the classroom scientific world. They must know that it is their obligation to make a program meaningful, especially by engaging and encouraging the teacher, by working with him or her as directly and as frequently as possible, and by being curious about the teacher's professional direction and goals.

Although the mentor will guide the teacher through the research experience, he or she should be willing to learn from the teacher as well. The teacher can lend insight about the state of science education and the implications for the scientist's own profession in the future. Mentors who have responsibility for teaching as well as research can benefit from discussions about teaching strategies.

Mentors should view the fellowship program as an apprenticeship for teachers, similar to apprenticeships in other professions, especially medicine and law. It may be useful for mentors to equate the teacher's fellowship experience with a researcher's sabbatical experience, in which a scientist may decide to engage in a completely new field of inquiry. By viewing the fellowship as a parallel endeavor in professional growth, the mentor may discover new ways to work with teachers.

From the outset, mentors should be aware of their duties and obligations *vis-a-vis* the teachers in the lab. Mentors must appreciate the significant commitment they must make to the fellowship. For example: the daily oversight of the teacher's work and progress, the need to allocate space for the teacher in the lab, and the importance of integrating the teacher into the day-to-day operations of the lab.

Set the Tone for a Working Relationship

Early in the program, the mentor and teacher should establish certain ground rules. The mentor should acquaint the teacher with the lab environment, describing the work that is being done and who is doing it. The mentor should introduce the teacher to all lab staff.

During the summer, mentors may frequently be away from the lab, either on vacation or attending professional meetings. In such cases, the mentor and teacher should establish a system of accountability, so that the teacher will always have someone to whom he or she can turn for assistance and guidance.

Mentors should demonstrate to teachers all safety procedures used in the lab and ensure that the teacher understands the importance of such procedures.

Guide the Teacher

The mentor's primary guidance to the teacher is in the form of designing and directing the teacher's research project. Mentors should assume teachers will have no expertise in the lab and that some level of training in procedures, techniques, and theory will be necessary. With this in mind, the mentor must develop a research project the teacher actually can conduct within the constraints of the summer fellowship. The project must set reasonable expectations. Mentors should consider the amount of training teachers may require, the time they have to work on a project, and other obligations that may interfere with the teachers' actual research work (such as the development of instructional materials or mandatory attendance at seminars).

Mentors should direct teachers to constructive activities that can be used during downtime in the lab, such as reviewing literature in the field that is appropriate for classroom application. Professional journals can bring teachers up-to-speed in the concepts associated with the work being done in the lab. Professional journals introduce teachers to the range of work being done in the discipline, as well as to the people doing that work and the issues that absorb them.

Assist in Development of Instructional Materials

Many fellowship programs require teachers to develop instructional materials. These materials often are the criteria by which a teacher's performance is evaluated.

Mentors should serve as subject-area experts for the development

Mentor Responsibilities in the Summer Fellowship

a. Help the teacher develop an appropriate research project within the program's timeframe.
b. Attend orientation sessions and introduce the teacher to your lab staff.
c. Provide the teacher with meaningful ways to use downtime, such as assisting other lab staff or reviewing professional journals.
d. Assist the teacher in developing and field-testing instructional materials.
e. Visit the teacher's classroom twice: once before the fellowship program to observe the teacher at work, once after the fellowship program, perhaps to talk to students about your work and career.
f. Complete institutional evaluations of the program and the teacher assigned to your lab.

Adapted from Biological Sciences Curriculum Study/Association of American Immunologists (BSCS/AAI) summer program.

of instructional materials. Teachers will turn to mentors for guidance, review, and technical assistance. Teachers will ask mentors for permission to test materials in the lab and to review materials for technical accuracy; they will ask for help in field-testing the materials, perhaps by being available for technical consultation.

Evaluate the Program and Teachers

Instructional materials may not be the only basis on which a teacher's performance is judged. Most institutions ask mentors to complete surveys that evaluate the teacher's performance, as well as the worth of the mentorship program.

During the course of the fellowship, the mentor may want to evaluate the teacher to offer direction and guidance. In such cases, it is useful for the teacher and mentor to set up a series of milestones to gauge the teacher's performance.

Institutions should encourage mentors to participate in follow-up activities with teachers, perhaps visiting the teacher's classroom and addressing students. Such follow-up promotes the idea of the fellowship as a professional development, an activity that benefits not only the teacher, but his or her students as well.

ROLE OF TEACHER

The most important role a teacher plays during a fellowship is that of student, suspending the authority and expertise he or she enjoys in the classroom to participate in and learn from the process of science. Despite a return to the role of the student, the teacher, like the mentor, should recognize that the teacher-mentor relationship is meant to be an apprenticeship, a time of professional development. The teacher's role should include elements that encourage the teacher to tell the mentor about the current state of science teaching, both in theory and in practice.

Participation in summer research experiences enrich teachers' professional lives in many ways. They should be encouraged to approach the experience with an open and receptive attitude. They should also be able to immerse themselves in the nature and method of science, with its many stops and starts, its false leads and laborious processes, its curious and intuitive approach to the nature of the world. This immersion should cause teachers to reflect on *how* best to convey this process to students in the classroom — how to translate the thrill and challenge of research so that science becomes more for students than a list of technical terms in a textbook or a dreaded lecture.

By participating in a research project, teachers should strive to learn as much as possible about the state-of-the-art in a particular discipline, becoming more current in the field. Teachers should learn theories, facts, and techniques clearly so that information is not distorted when presented in the classroom.

Teachers should reflect on more useful and practical ways to teach science, ways that invite students to participate more fully, becoming more creative in their approach to science. Teachers should consider ways to involve students in authentic research so that students learn to ask questions and find answers, rather than to rely simply on the teacher's knowledge or to complete a cookbook of lab experiences.

Fulfill Lab Obligations

The mentor should clearly discuss the teacher's obligations in the lab, and the teacher should understand the extensive commitment required by scientific research. Often, teachers are surprised to discover that science is not done on a nine-to-five schedule. Teachers, like other lab employees, must keep flexible hours.

The teacher should understand that he or she is expected to be a full participant in all lab activities, attending weekly lab meetings and working with all lab staff. The teacher should become a *member* of the lab staff, not just a *visitor*.

Teachers should discuss their progress with their mentors. These discussions should go beyond whatever formal evaluations are conducted. Instead, teachers should seek mentors' advice, response, and guidance throughout the fellowship. Teachers also should let mentors know whether or not they are receiving adequate guidance and assistance. Teachers should ask questions such as:

- Is my work helping the lab achieve its goals?
- Can I improve my work? What steps would help me to progress?
- What else can I do in the lab to benefit from the fellowship?

Teachers should realize that science is often a slow-moving process. During down periods, they should undertake additional tasks such as reading professional journals or assisting another lab member. Teachers should realize that being assigned from one lab staff person to another is not just "busy work," but is truly a way in which they can benefit from the fellowship.

Develop Instructional Materials

Many programs require teachers to develop instructional materials. The process enables teachers to integrate their fellowship experience with their teaching practice. The teacher must understand the steps necessary to complete this process, from working with the mentor to field-testing materials for accuracy, as well as for clarity of instructions and background text. If the materials are to be developed cooperatively by several teachers, the teacher must attend all meetings and meet project deadlines. The development of instructional materials is described in detail in Chapter 3.

Evaluate the Program

Teachers should provide feedback about their particular experiences in the fellowship program and about their sense of the program in general. They should complete all program evaluation surveys and participate in follow-up interviews or surveys. They should evaluate the mentor and the mentoring relationship.

Sample Teacher Responsibilities in the Summer Fellowship

a. With your lab mentor, develop a suitable research project that can be investigated and completed during the fellowship period.
b. Attend the orientation session.
c. Complete all necessary paperwork, including forms for income-tax withholding, institutional confidentiality agreements, and continuing education credit.
d. Meet the standard, full-time working requirements of your lab.
e. Develop professional relationships with lab staff to learn more about their work and experience in the field.
f. Provide the program planner and your mentor with a statement of your assignments by the end of the first week.
g. Attend weekly science meetings of your lab.
h. Attend seminars offered to teacher-fellows throughout the program.
i. Meet weekly with fellow participants to review progress and to discuss your work.
j. Complete all program surveys and evaluations. Attend the follow-up meeting in December.

Sample Teacher Responsibilities for the Development of Instructional Materials

a. Work with fellow participants and mentors to develop and test instructional materials by the end of the program.
b. Meet weekly with fellow participants to discuss development of instructional materials.
c. Provide a draft copy of the instructional materials by the end of the program.
d. Field-test your instructional materials at the start of the school year. Collect written responses from students. Write and submit a report on the usefulness of the materials to the program planner, your mentor, and your curriculum area supervisor.
e. Based on the field test and student response, revise the instructional materials. Submit revisions to the program coordinator, your mentor, and your curriculum area supervisor.

Complete Administrative Tasks

The teacher is responsible for attending the orientation session, completing necessary institutional paperwork, and adhering to institutional standards (such as confidentiality agreements).

The teacher should resolve any financial issues, such as the timing of stipend payments or income-tax withholding, before the program begins.

Institutions should work to have their programs accredited, and if this is in place, the teacher should complete steps necessary to receive the appropriate credit.

ANTICIPATE CULTURE SHOCK: LAB ETIQUETTE FOR TEACHERS

If the fellowship program is indeed a cultural exchange of sorts, then program planners should appreciate, and anticipate, the culture shock teachers experience when first entering the lab. The transition to the lab from the world of the classroom and school can be as startling as a first visit to a foreign country. Like foreign exchange students, however, teachers quickly become acclimated to the lab.

The greatest adjustment for many teachers is the realization that the lab does not operate on an eight-hour workday. Although most teachers do keep odd hours — staying after school to grade papers or counsel students and attending school functions during the week — the constant and unpredictable work in a lab may startle many teachers. Teachers frequently express surprise that someone is *always* in a lab, running an experiment, waiting for results, preparing a presentation. As they assimilate lab work and become more involved in their own research, teachers quickly find that their seven-to-three or nine-to-five orientation gives way to the task orientation of the lab.

Host institutions and mentors should introduce teachers to local customs. Each research environment adheres to its particular, and sometimes peculiar, norms. Government labs are structured differently from those of business and industry. University labs have their own conventions. Each lab environment has its own etiquette, and unless lab staff explain this etiquette to teachers, *faux pas* can easily occur. One teacher described, for example, the stir he created in a private lab when he discussed his salary openly. Although public school teachers are used to having their salaries be a matter of public record, researchers in private industry are not. Avoid such awkward moments by addressing these issues early.

Explain the staffing hierarchy of the lab, discussing the role and responsibility of each staff member and describing the lab's usual chain of authority. Most teachers will not be able to tell a graduate student from a lab technician, a principal investigator from a research fellow. Take time at the outset to explain the different staff positions.

Discuss the institution's conventions and hierarchy as well. If a university's chemical engineering department never shares data with its biomedical department, tell the teacher that this is so. Tell the teacher how to handle requests for information from the media or from other labs. By giving teachers this information, mentors and institutions can reduce breaches in lab etiquette, ensuring that all participants feel relaxed and comfortable with one another and with the roles they are expected to play.

3. DEVELOPMENT OF INSTRUCTIONAL MATERIALS

Many summer fellowships include a component for the development of instructional materials. Developing such materials gives teachers an opportunity to reconsider the ways in which they talk and think about, and ultimately teach, science. Materials development permits teachers to refine and improve the ways in which they present scientific materials to students and provides teachers with a tangible and practical outcome from the summer fellowship.

Mentors are expected to assist teachers in developing instructional materials by providing technical assistance and guidance, as well as materials and supplies. Mentors should help teachers select an appropriate concept and approach, as well as an experimental design that will work in the classroom. In addition, mentors often are asked to assist in field-testing and revising products.

Instructional materials serve a practical, programmatic purpose. Host institutions and school districts find such materials provide a method to quantify work done in the lab. The materials can serve as supporting documents for justifying a program and for grant applications. Materials can be used in promotional efforts and can be distributed at meetings of professional societies and teacher associations. Finally, teachers may use the materials at the local level (i.e., in-service programs with other teachers), to demonstrate the effect of the fellowship program on his or her teaching practice.

Some school districts distribute instructional materials throughout their classrooms, although widespread distribution is not the primary objective of materials development. As an outgrowth of one or several teachers' experiences, instructional materials prove most useful in these teachers' own hands and classrooms, giving them a way to translate the experience of the research lab to a hands-on experience in the classroom. Consequently, the program's goal should be to have teachers develop *one* instructional activity that is *not* a lecture, rather than an entire year's worth of materials or materials that can supplement an entire science curriculum.

Ideally, materials development should be a cooperative effort among teachers and mentors. In many ways, cooperative development mimics the research environment, in which many people work together to achieve common goals. Teachers who work together should be given opportunities to meet and discuss their project, much in the way labs hold weekly meetings to review progress. These teachers also should meet to discuss the results of field tests and to revise their product accordingly.

PURPOSES FOR TEACHERS AND FOR STUDENTS

The development of instructional materials serves distinct purposes for teachers and for their students. For teachers, the materials are primarily a way to integrate the lab and fellowship experience with actual teaching methods. Because the product evolves from some aspect of the teacher's research, which itself evolves from some aspect of the lab research, the product can provide a way for the teacher to talk to students about the research experience. The materials offer a perfect opportunity for the teacher to invite the mentor to the classroom to discuss not only his or her work, but to discuss scientific inquiry in general. In some cases, it may even be possible for teachers to take a class to the lab, so that students can witness scientific research.

For students, the primary purpose of the instructional materials should be to *experience* scientific investigation about a specific topic, rather than simply to read a textbook on the topic or to memorize facts about it. One way to help the student truly benefit from the activity is to relate the activity or its lessons to the student's own life.

The product should teach students how to:

- Pose *good* questions about a particular subject, much as scientists pose questions related to their discipline;
- Develop hypotheses;
- Conduct careful experiments;
- Collect, analyze, interpret, and evaluate data, transforming it to answer original questions and to state conclusions.

THEORY AND APPROACH

Theory

Learning is generally viewed as a three-step process: students acquire knowledge, integrate new materials with what they already know, and apply what has been learned to their own experience. In this three-step process, students often construct their own knowledge. Consequently, instructional materials must acknowledge common misconceptions about various subjects and provide ways for students to *disprove* their own misconceptions. In addition, materials should take a multicultural approach, acknowledging any relevant cultural differences.

Within this theory, the teacher's role is that of a coach. Instead of inculcating students with series of facts, the teacher *guides* the student in meaningful learning experiences, so that facts emerge from the student's own experience. The teacher initially provides a student with some fact or bit of information and then guides the student in integrating the fact with what the student has already learned. Finally, the teacher directs the students in applying this knowledge to their own lives.

For example, students might first discuss their own ideas about the causes of mental and addictive disorders. The teacher might then introduce the students to some models that demonstrate the contributions of biology and the environment to complex human traits such as intelligence. The students could speculate on the ways in which genes and environment might interact to cause mental and addictive disorders and discuss the implications of that speculation for prevention, treatment, and research. They might propose specific hypotheses about the causes of addiction and mental illness and design experiments that test those hypotheses. Consideration of experimental design would require the students to apply the nature and methods of science and might require them to explore the ethical issues involved in the use of human subjects, the regulations that govern the use of animals, and the benefits and limitations of animal models.

The students might discuss experiences with addiction or mental illness in their families or among friends, thereby relating the science to personal and societal issues.

Practice

Select concept and approach. As the mentor and teacher work to select an appropriate concept and approach, both should take steps to ground the product in current educational theory and research. Materials should be developmentally appropriate, incorporating the various stages of educational development. A sixth-grade science student is at a very different developmental level from an eighth-grader, and materials must acknowledge such differences.

Materials should relate not only to the existing curriculum, but to students' own experience. For example, materials that involve an investigation of the human heart may also include information about how to ensure a healthy heart. Thus, materials should involve authentic problems. These problems not only should be based on what scientists have done in the lab, but on what students encounter in their daily lives.

Finally, mentors should realize that most school districts operate within very limited budgets and that school science labs cannot provide state-of-the-art materials. For some school districts, a Bunsen burner might be as treasured and as hard to come by as an infrared spectrometer. When developing products, teachers and mentors should take care to ensure that any materials required in the classroom be readily available and inexpensive. The product should also satisfy local school safety requirements and Occupational Safety and Health Administration safety regulations. Hazardous and dangerous materials that may be used regularly in a lab, such as hydrochloric acid, are not appropriate in an elementary school science classroom.

Obtain technical and financial assistance. Teachers will require technical support and assistance from mentors and other staff. This assistance is especially important not only in selecting a concept and approach, but in developing a product that really works in the classroom. Mentors and other lab staff should be prepared and willing to help teachers, to assist them in trial runs of a product, to test a product in the lab, to review it for scientific accuracy, and to revise it if necessary. During the school year, mentors should be available by telephone or electronic bulletin board to help teachers overcome any problems that might arise when the product actually is introduced in the classroom.

Teachers also will require the support of their local school districts, especially their curriculum specialists and science teaching centers, and teachers and mentors should be able to call upon these specialists for guidance in selecting materials, concepts, and approaches. Curriculum and science-education specialists can ensure that materials are developmentally appropriate, satisfy educational theory and practice, and meet safety requirements. Curriculum specialists also will be able to gauge whether or not the material is financially accessible for a school district and whether it can be incorporated into the classroom.

For materials that require some degree of financial support, assistance may be sought from local school districts, host institutions, or sponsoring partners. School districts and mentors, for example, often can provide or lend materials to classrooms. Sponsoring partners may provide funding to purchase any necessary (and reasonable) equipment. Financial assistance, usually in the form of grants, may be forthcoming from local agencies.

Write, review, and field-test materials. As teachers write and field-test instructional materials, and as mentors review them, they should consider the following:

- The materials should be formatted and presented to reflect local curriculum standards and conventions. Curriculum area specialists can usually guide teachers in satisfying this requirement.
- Mentors should review all materials for scientific accuracy.
- Mentors should review all materials and procedures for safety.
- A curriculum specialist should review materials to ensure that they are developmentally appropriate and provide a valuable learning experience.
- Teachers and mentors should edit and proofread materials. This is especially important for any materials that are to be widely distributed. In such instances, institutions may ask their own publications offices to review materials for style and content.

In field-testing instructional materials, teachers and mentors should:

- Assure that all instructions are accurate and clear. Consider the final target audience — the student.
- Assure that all procedures are explained clearly and can be accomplished in the teacher's classroom.
- Conduct the experiment in the mentor's lab. Test all procedures. Review outcomes. Correct materials as necessary.

If a group of teachers develops a product, such as an experiment, cooperatively, the original group should meet after the materials have been introduced and used in the classroom. The group can then compare experiences and revise materials accordingly. Mentors also can participate in the process. If the materials are being distributed by host institutions or by school districts, their representatives should attend this meeting to hear how the materials have been received in the classroom. By attending such meetings, program planners will have another mechanism for program evaluation.

APPENDICES

SAMPLE APPLICATION FOR SUMMER FELLOWSHIP PROGRAM

Sponsoring Institution
Program Dates/Location

Please complete this form and return with the following attachments to:

____

(Address—Sponsoring Institution)

Attachments:

1. A current resume.
2. A 500-word statement describing your areas of interest, how you expect to benefit from participating in the program, and how you will apply what you have learned in your classroom. Include a brief statement about your education, your teaching experience, and the curriculum you now teach. Discuss your curriculum-development experience, level of computer expertise, and lab or technical experience. Describe other relevant work experience, such as summer employment or extracurricular programs.
3. Two letters of recommendation: one must be from a supervisor; one may come from a colleague.

(Please print)

Name: ______________________________

Home Mailing Address: ______________________________

____

____

Phone: *(include area code)*

Work: (_____)__________ **Home:** (_____)__________ **FAX:** (_____)__________

School Name: ______________________________

Principal: ______________________________

School District: ______________________________

School Mailing Address: ______________________________

____

____

Subject taught: ____________________ **Grade level:** __________

Subject taught: ____________________ **Grade level:** __________

Subject taught: ____________________ **Grade level:** __________

Adapted from Association of American Immunologists (AAI) Internship Program.

SAMPLE HOST INSTITUTION SUMMER FELLOWSHIP PROGRAM POST-PROGRAM SURVEY OF TEACHERS

The survey should include questions that are specific to elements of your institution's program. For example, teachers should be asked to evaluate any seminars they may have attended and the usefulness of the instructional materials they developed. In some cases, institutions have found that a two-part survey, one part administered immediately after the end of the session and one part in December of that year, provides the greatest insight.

Please complete this survey and return to:

Name of Program Coordinator

Name: ______________________________

Mentor: ______________________________

Date: ______________________________

1. Did the fellowship meet your expectations?

   Yes______ No______

   Briefly state why or why not, giving specific examples when possible. Please evaluate the program's structure and organization, as well as the work you accomplished.

   ____

   ____

   ____

2. What do you think were the most important results of your experience in the lab? Please address personal and professional growth, as well as the applications you developed for your classroom. Do you think your colleagues can benefit from your experience, for example, either through the instructional materials you developed or from your sharing information about the program with them?

   ____

   ____

   ____

3. As you entered the program, you may have had some concerns or apprehensions. Did you encounter any problems during the course of the summer? How might we have addressed these problems?

   ____

   ____

   ____

4. How did you benefit from the mentoring relationship? From interactions with other lab and institutional staff?

   ____

   ____

   ____

5. Do you now include information about [the host institution's primary research focus, such as human genetics] in your curriculum? Will your research experience enhance your ability to teach in this subject area?

   ____

   ____

   ____

6. Do you currently teach students about careers in the life sciences? Will your research experience enable you to include more career-oriented information?

   ____

   ____

   ____

7. Does your curriculum currently include a unit on the interrelationship of science, technology, and society? Will your summer experience help you communicate more of this material to your students in a more effective way?

   ____

   ____

   ____

Adapted from Biological Sciences Curriculum Study/Association of American Immunologists (BSCS/AAI).

SAMPLE HOST INSTITUTION SUMMER FELLOWSHIP PROGRAM POST-PROGRAM SURVEY OF MENTORS

Please use the following code to answer questions 1 to 13

SA = Strongly Agree　**A** = Agree　**U** = Undecided
D = Disagree　**SD** = Strongly Disagree　**N/A** = Not Applicable

1. The teacher and I were well-matched professionally.	SA	A	U	D	SD	N/A
2. The teacher contributed to my lab's project.	SA	A	U	D	SD	N/A
3. My staff benefited from the teacher's presence and work.	SA	A	U	D	SD	N/A
4. The teacher was well-informed:						
a. About the field in general.	SA	A	U	D	SD	N/A
b. About the project in particular.	SA	A	U	D	SD	N/A
5. The teacher was prepared for the fellowship.	SA	A	U	D	SD	N/A
6. The teacher's work was excellent.	SA	A	U	D	SD	N/A
7. The institutional liaison was helpful.	SA	A	U	D	SD	N/A
8. I would have liked to have been more involved in planning the fellowship program.	SA	A	U	D	SD	N/A
9. I learned about science education theory and practice from the teacher.	SA	A	U	D	SD	N/A
10. I enjoyed assisting the teacher in developing instructional materials.	SA	A	U	D	SD	N/A
11. I would like to participate next year.	SA	A	U	D	SD	N/A
12. I would like to help plan next year's program.	SA	A	U	D	SD	N/A
13. I plan to continue contact with the teacher:						
a. Visiting the classroom	SA	A	U	D	SD	N/A
b. Field-testing instructional materials	SA	A	U	D	SD	N/A

Additional Comments:

14. The following criteria are important in selecting teachers for fellowships. Please rank on a scale of 1 (least important) to 9 (most important).

____ Educational background

____ Computer literacy

____ Computer expertise

____ Prior experience in business, industry, or university lab

____ Knowledge of current lab techniques

____ Several years of teaching experience

____ Motivation and interest

____ Ability to translate fellowship experience to classroom

____ Interpersonal skills

____ Self-directed learning skills

Other Comments:

15. Please share your ideas on how the program might be improved in the future. Please address improvements in planning and organization, selection of teachers, and role of the host institution.

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