Project Description

I. Introduction, Need, and Vision for the BiosciEdNet (BEN) Pathway

The BiosciEdNet (BEN) Collaborative is seeking support under the National Science, Technology, Engineering, and Mathematics Education Digital Library (NSDL) Pathway Track to facilitate the wider dissemination of resources developed by biological sciences professional societies and coalitions that provide resources, tools, and professional development for educators at the high school and undergraduate levels (including community colleges) by expanding its stewardship role.

This expansion will include technical assistance and training for staff at professional societies or coalitions, faculty at undergraduate institutions, and introductory and high school biology teachers. It builds on the successful groundwork and outreach of the BEN Collaborative and will address the pressing need for scientifically accurate biological sciences education digital library resources and related services. This need has become more acute in recent years for a number of reasons, including the following:

- The U.S. No Child Left Behind (NCLB) legislation, has led to an increase in the number of students taking biology as their required high school science course, and thirteen states are already piloting end-of-course (EOC) assessments in biology (Sommerville, Levitt, and Yi, 2002). In addition, there has been a rapid expansion of AP biology courses, and more than 9000 AP biology courses were offered in 2000 (National Research Council, 2002). **As a result, teachers of introductory and AP biology courses need access to resources that meet state science educations standards and foster inquiry-based learning and problem-solving rather than memorization of facts and "cookbook" laboratory experiments.**

- The number of college and university students taking biological sciences classes has increased rapidly in recent years (Howard Hughes Medical Institute (HHMI), http:www.hhmi.org/BeyondBio 101/world.htm). In addition, new research directions in nanotechnology and informatics mean that all STEM majors, and not just biological sciences majors need an in-depth understanding of the biological sciences. For non-science majors, faculty are looking for teaching resources that help prepare these students for public issues related to the biological sciences, such as stem cells, cloning, and gene therapy and environmental and conservation issues. For biological sciences education majors, faculty members need materials that emphasize the best practices in high school pedagogy.

  In addition, Biology 2010 (National Resource Council, 2003) indicates the following --- "Adaptable modules for course enrichment that take full advantage of interactive computer programs and multimedia educational tools are a very attractive complementary means of strengthening undergraduate biology education. They can be designed for class use or independent study." **Therefore, college and university educators need access to high quality biological sciences teaching materials and tools that build problem-solving and research skills of both STEM majors and non-majors.**

Why focus on both college/university and high school education? There are significant educational commonalities between these levels. Expanding the BEN stewardship on both levels would allow for the development of future NSDL services that provide for greater articulation between high school and college and university biology content as called for by the NRC Biology Content Panel (National Research Council, 2002). This panel report indicates that there is already a connection between the AP biology examination and college and university introductory biology. Although not recommended as a practice, colleges and universities often use high school

AP biology examinations for determining student eligibility to bypass college and university introductory biology courses.

The BEN Collaborative is already prepared to expand resources in this area; although we initially focused on biological sciences undergraduate education, most of the BEN Collaborators previously planned their digital libraries to include high school and higher education resources and have professional development programs at multiple levels. The BEN metadata standards at present include fields for grade levels and information on science education standards.

Why focus on biological sciences? The BEN Collaborative believes that educators come to digital libraries with broad subject areas in mind. If, for example, resources in all areas of science are aggregated together simply because they are usable at the undergraduate level, the efficiency of the user's resulting searches may be diluted to the point of dysfunctionality. Such searches would differ little from existing Google or Yahoo Science directories.

Furthermore, assuring that items produced by a search of so many diverse fields have scientific merit and educational value would require garnering the content and pedagogy expertise of a vast array of participants. Finally, providing appropriate technical assistance for an endeavor of this size would either exceed the confines of reasonable funding or limit the depth and breadth of technical assistance to both content and service providers. Therefore, the BEN Collaborative has elected to keep the broad and ever-expanding fields of biological sciences as its core focus.

Why focus on professional societies and coalitions? Stewardship must encompass more than simply aggregating resources and crawling existing collections; this model has been extensively developed by sites such as Google and Yahoo. In order to sustain the NSDL, stewardship must build the capacity of organizations that have long-standing and ongoing commitments to supporting high quality, inquiry-driven, active, and engaging STEM education in both formal and informal settings at multiple education levels.

Professional societies are already stewards for their disciplines, their members, and the larger STEM community in terms of research, education, and public understanding of science. They are, therefore, natural NSDL Collaborators as demonstrated by the successful initial development and expansion of the BEN Collaborative (see below). Thus, in the proposed project, the **BEN Collaborative seeks to expand its NSDL stewardship to include technical assistance, tools, guidelines, professional development, and mentoring for professional societies and coalitions to build, maintain, and sustain high quality digital libraries that include metadata for individual biological sciences learning resources or objects.** Technical assistance will use existing BEN and NSDL tools and resources but will also contribute new resources and tools to the NSDL collection.

II. About the BEN Collaborative

In 1999, the American Association for the Advancement of Science (AAAS) Directorate for Education and Human Resources (EHR) Programs and *Science's* Signal Transduction Knowledge Environment (STKE) --- with 11 other professional societies and coalitions for biological sciences –established the BiosciEdNet (BEN) Collaborative. Since its inception, BEN has grown from the original 11 to 13 Collaborators that are providing resources to the NSDL BEN portal.

The goal of the BEN Collaborative is to transform teaching and learning in the biological sciences. BEN approaches this goal via two major foci:

1. Through the BEN portal site, the BEN Collaborative provides searchable and seamless access to the digital library collections of its Collaborators to provide users with accurate and reliable biological sciences education resources. Resources accessible through the site will impact the learning of the biological sciences by students with diverse interests and career aspirations. The materials are collected and maintained by respected professional societies representing a broad spectrum of biological sciences; and

2. Through the BEN Collaborators, BEN serves as a catalyst and a technical support mechanism for biological sciences professional societies and coalitions that seek to build their own education-focused digital libraries and to collaborate in terms of pedagogy, authentic assessment, and development of multidisciplinary biological sciences resources.

Currently, the digital library collections of BEN Collaborators provide a rich array of materials for undergraduate biological sciences educators, including ones that prepare K-12 teachers. In addition, a growing number of materials are focused on graduate and medical school educators, as well as for high school educators.

The materials that users find via the BEN portal are unique in several ways. First, BEN resources have been reviewed by the individual societies for standards of quality and accuracy. Although each BEN collaborator has unique review criteria, overall users find resources that are scientifically accurate and educationally sound. Second, the BEN portal provides an extended set of search parameters to allow more productive searches by users. Finally, due to the collaborative establishment of its metadata structure, the user can easily conduct productive interdisciplinary searches across the diverse biological sciences topics covered by the BEN Collaborators, as recommended by BIO 2010.

In general contributors can submit resources through the digital library of a BEN collaborator or directly to the BEN portal. Submissions to the BEN portal are sent to the Collaborators that are maintaining discipline specific resources. For contributors that do not fit discipline-specific Collaborators, AAAS reviews and catalogs submissions. Contributors enter the cataloging information at the time of submission, and a BEN digital library provider or AAAS validates the metadata.

Also, many BEN Collaborators have access to existing resources that can be cataloged (metatagged) given additional staff resources. For existing resources, AAAS and Collaborators catalog resources and validate metadata that are specific to their discipline, mission, or membership.

The structure and governance of the BEN Collaborative include the:

- **BEN Coordinating Council** --- Executive or Education Directors, or other representatives from the 8 organizations that are receiving NSDL funds are members of the Council.
- **BEN Technical Committee** --- Technical services staff members and consultants of BEN Collaborators
- **BEN Secretariat ---** AAAS serves as the Secretariat and manages the BEN portal site that aggregates the resources of Collaborators that have digital libraries or for Collaborators that just want to catalog (metatag) resources for harvesting by the NSDL Core Integration (CI).
- **BEN Advisory Board** --- Twenty (20) members, 17 of whom are faculty members from all types of colleges and universities comprise the Board. The Board advises the BEN team on strategies for the digital libraries, including developing faculty contributors and users,

sustainability, and research and evaluation. The Appendix includes a list of BEN Advisory Board Members, Council, and Technical Committee members.

Building and supporting a diverse contributor/user base for the digital libraries is one of the most critical issues that BEN faces. Since undergraduate biology is a core course in many colleges and universities and high school biology educators tend to teach 4 to 5 biology classes a day, these educators often have severe constraints on both time and resources.

Biological sciences educators, particularly in high schools and community colleges and regional comprehensive institutions, have student bodies diverse in every respect – learning styles and ability, geography, economics, race, gender, physical disabilities, and experience. To this end, BEN Collaborators are building digital collections that are inclusive of all educators and students.

In addition, to ensure diversity, BEN will make presentations and exhibit at meetings of grantees of both the National Science Foundation (NSF) and the National Institutes of Health (NIH) programs for underrepresented minorities in science, women, and persons with disabilities and at minority and women-based STEM professional society meetings.

III. Accomplishments and Progress of the BEN Collaborative

With funding from the NSF, professional societies, and other sources, the BEN Collaborators have accomplished the following:

1. **Developed metadata and technical specifications that meet the requirement of the NSDL.**

BEN Collaborative item level metadata meets all of the requirements identified by the NSDL CI. The BEN Collaborative developed a metadata specification based on IEEE LOM, which is cross-walked to the NSDL required Dublin Core Qualified with the Educational Extensions (DC-ED) and includes controlled vocabularies for Audience Education Level, Subject, and Resource Type. The BEN Collaborative vocabulary is a controlled vocabulary for biological sciences topics and is not proprietary in any way.

When completed in October 2001, the BEN metadata specification (including all controlled vocabulary) was submitted for posting on the NSDL communications portal and made available for comments from the NSDL community. Additionally, the specification is publicly available at the BEN portal site at http://www.biosciednet.org/project_site/ These specifications include: (a) BEN metadata Repository Database Specification; (b) XML specification and schema for transferring BEN Learning Object Metadata (LOM); (c) Search Engine Specifications; (d) Metadata Harvester Software Specifications using the Open Archive Initiative (OAI) Protocol; and (e) Cataloging Software Specifications.

In August 2003, the BEN portal site upgraded the original implementation of OAI to Version 2 as required by NSDL CI for metadata harvesting. The checklist recommended by the NSDL CI was followed, and the BEN portal site OAI server passed validation by both the OAI and NSDL OAI validator programs in September 2003.

2. **Developed and upgraded the BEN portal which aggregates the resources of BEN Collaborators for the NSDL**

In 2002, there were three major software development efforts related to the launching of the BEN portal --- search engine, metadata harvester, and cataloging tool development.

- The search engine provides users with access and cross-searches to educational resources of the BEN Collaborators.
- The metadata collection and indexing tool is a portable metadata harvester based on the IEEE LOM 6.1/BEN 1.0 metadata standards that transmit learning resource metadata from the collections of the BEN member societies to the BEN portal site.
- The resource submission or cataloging tool routes the user to a BEN Partner that accepts online submissions of resources. For BEN Collaborators that do not have an online submission process but do have an education resources page, the user can enter the data about their resource in the BEN catalog with links to a Partner's education page.

In terms of accessibility and portal site design, BEN used the guidelines for World Wide Web Consortium (W3C) Web Accessibility Interface. http://www.w3.org/TR/2001/WD-WCAG20-20010824/ and http://www.w3.org/TR/WCAG20/

At launch, the BEN portal site currently consists of a home page, three main content areas (About BEN, Use BEN, and Teach with BEN), and administrative services (Login/Logout, Join BEN, Contact BEN, Policies, Help, & Sitemap). The following is a list of the applications that are functional at the BEN portal site (http://www.biosciednet.org/portal/) --- include (a) simple login/password access management; (b) user registration and user profile update; (c) basic keyword search and advanced search using selected metadata fields; (d) browse by resource type and browse by subject; (e) contributor cataloging tool; and (f) administration tools– metadata, harvester, and user registration/profile management.

In 2003, other functions developed or added to the portal site included:

- Administrative Reporting Tools that provide summary reports on user demographics (teaching audience, institutions, departments, and region), user registration rate by selected time periods, and catalog contents by contributing partner.
- New security architecture for registered BEN portal users to include a metadata validator role in addition to searcher, cataloger, and administrator.
- A metadata validation work flow system that provides a review of metadata before it is accepted and available for harvesting. The validator confirms the accuracy of or corrects the subject, audience levels, or other descriptive information.
- Automated response system to handle request for forgotten passwords.
- User support for registration that includes information on use of cookies and enabling cookies in a variety of browser products.
- Integration of the project document page into the main portal site information section and information on BEN Advisory Board.
- Extension of the controlled vocabulary for subject (discipline) and resource types to accommodate collaborator requirements.
- A link checker that can check links contained in the metadata database.

In 2003-2004, upgrades were done to improve the metadata database architecture to allow cataloging to occur into databases owned and managed by partner organizations and eliminated cataloging into the master database. Now all data is harvested from various databases, whether hosted physically at AAAS or at the sites of Collaborators.

Also, improvements were made to the metadata harvester/reaper software to resolve problems and increase performance and to the BEN server infrastructure to enhance performance particularly to eliminate timeouts on search results and speed up the return of search results. The harvester architecture is scalable and will support the increase in partners and metadata records.

The performance of the browse and search services are monitored and changes will be made to ensure users can easily find resources as the number of resources increases.

In addition, a draft operating procedures guideline has been developed for supporting the portal and interacting with technical staff at each of the collaborator sites to ensure quick response and resolution to technical problems.

3. **Provided technical assistance to societies for the development of digital libraries or for cataloging resources and validating metadata.**

In 2002, BEN provided technical assistance for the development of three new digital libraries for the APS, ESA, and ASBMB. In addition, ASM and STKE modified their technical infrastructure to meet the NSDL metadata standards and technical specifications. URLs for these libraries are as follows:

- http://www.apsarchive.org/main/index.asp
- http://www.microbelibrary.org/
- http://www.ecoed.net/
- http://stke.sciencemag.org/resources/education/
- http://www.biomoleculesalive.org/

In 2003-2004, BEN portal manager and technical team provided database development, cataloging, and metadata validation software tools for five societies – the American Phytopathological Society, ABLE, BSA, FUN, and SOT. APS provided a similar service for HAPS. The BEN technical team developed a database and copies of the cataloging and metadata validation tools at AAAS so that BEN and the NSDL can harvest resources of smaller organizations that lack technical infrastructure.

In addition, the team developed a Perl script so that the Excel spreadsheet annotations of the Botanical Society of America (BSA) could be converted to the BEN metadata specifications --- http://www.botany.org/plantimages/ In January 2005, BEN technical team provided database development and technical support for the implementation of AIBS catalog and harvesting tools for their ActionBioscience.org site. -- www.actionbioscience.org

BEN Collaborators retain rights to their e-resources (electronic resources) and the responsibility for managing, entering, and ensuring the quality of their metadata. The BEN portal manager does not have the privileges or right to manipulate the databases of Collaborators. For existing resources staff and volunteers are entering the metadata. In addition, for new submissions, contributors enter their own metadata, and staff or volunteers validate the metadata.

These services have increased the number of peer-reviewed individual biological sciences learning objects or resources aggregated at the BEN portal from 680 in 2002 to nearly 3,700 peer-reviewed e-resources in April 2005. Much of the increase in the BEN catalog has been due to acquisition of existing collections versus contributor submissions. Increasing the number of resources in the catalog is directly linked to having the funds for development of digital libraries and cataloging and validating metadata. While these numbers of resources appear to be low, BEN is one of the few NSDL projects with a large number of peer reviewed individually tagged lessons and classroom activities.

The thirteen (13) BEN Collaborators contributing resources to the portal are listed in Table 1. Table 2 includes nine (9) new organizations that are included in this proposed project. If this project is funded, these 22 organizations expect to increase the number of peer-reviewed e-

resources available for NSDL harvesting from nearly 3,700 to over 27,000 peer-reviewed resources (See Table 3).

Table 1 --- Name of Societies and Number of Resources Harvested by BEN (Total Resources = 3,676))

Collaborators	Number of Resources Harvested
American Association for the Advancement of Science (AAAS)*	**147**
Science*'s Signal Transduction Knowledge Environment (STKE)	**252**
American Institute for Biological Sciences (AIBS)*	**166**
American Physiological Society (APS)*	**418**
American Phytopathological Society (APSnet)	**50**
American Society for Biochemistry and Molecular Biology (ASBMB)*	**39**
American Society for Microbiology (ASM)*	**1141**
Association for Biology Laboratory Education (ABLE)	**72**
Botanical Society of America (BSA)	**948**
Ecological Society of America (ESA)*	**154**
Faculty for Undergraduate Neuroscience (FUN)	**14**
Human Anatomy and Physiology (HAPS)	**266**
Society of Toxicology (SOT)*	**9**

*BEN Council members

Table 2 – Proposed Additional BEN Collaborators

Bio-Link (The NSF Advanced Technological Education Center for Biochemistry)
BioQuest Curriculum Consortium (BCC)
Dolan DNA Learning Center (DNALC)
Entomology Digital Library (EntDigl)
National Association of Biology Teachers (NABT)
National Association of Health Sciences Education Partners (NAHSEP)
Society for Developmental Biology (SDB)
Society for Integrative and Comparative Biology (SICB)
Video and Image Data Access (VIDA) for Science Inquiry During Teacher Preparation

IV. Proposed Plan of Action for the BEN Pathway

A. Goals and Objectives

The plan of action described below focuses on the NSDL Pathways goals by paving the way for both large and small biological sciences organizations to review, prepare, and catalogue their exemplary educational materials for dissemination via both BEN and NSDL. By focusing on biological sciences organizations and faculty, the specific value-added services that will facilitate the identification of potential contributors (organizational and individual), their actual contributions, and the preservation of their materials and links can be customized for life sciences while bridging the technical gaps to bring the metadata of those resources into the NSDL repository.

BEN Pathway Project goals and objectives were developed in line with the Pathways goals and objectives. Specifically, the **BEN Pathway Project's goal is to serve as an NSDL steward for professional societies and coalitions to build, maintain, and sustain high quality digital libraries that include NDSL-compatible metadata for individual biological sciences learning resources or objects.**

Toward this end, the BEN Pathways Project will provide technical assistance, tools, guidelines, professional development, and mentoring for both organizations and individuals. The BEN Pathway Project impact objectives focus on stewardship in three primary areas: A) Building the capacity of biological sciences organizations to create new digital libraries and/or catalogue collections for metadata harvest; B) Developing Faculty Campus Representatives to provide grassroots training on using and contributing to digital libraries; and C) Increasing the overall biological sciences resources stewardship by increasing the collection of vetted items within BEN and accessible through NSDL.

B. Project Activities

As evidenced by the mission and progress to date, BEN is well positioned to serve as the Biological Sciences Pathway for the NSDL. The BEN portal already provides technical assistance and services that aggregate the resources of 13 Collaborators. Funding from this proposal would allow us to aggregate the resources from all 22 of our Collaborators. Specifically, BEN Collaborators are seeking funding for the following 3 objectives:

1) Increasing user access to a wide variety of biological sciences resources from BEN Collaborators and other content and service providers designated by the NSDL Cooperative Agreement (CA) by increasing the participation of more biological sciences-related organizations in contributing metadata to BEN and, subsequently, to NSDL.

Biological sciences resources will be aggregated at the BEN portal in two different ways.

- Smaller organizations often lack the technical infrastructure and, in many cases, paid staff. For these organizations, a database and copies of the cataloging and metadata validation tools are implemented at the BEN portal site or at the site of a collaborator (e.g, HAPS partnership with APS). These organizations are responsible for metatagging, validating, and maintaining their resources, and the databases of these smaller organizations are harvested like any of the other BEN collaborator databases.
- Organizations that wish to convert their e-resources to create a new digital library need technical staff or consultants and a well established technical infrastructure. These organizations will receive mentoring and technical assistance from BEN partners and the technical team, along with the specifications to develop a digital library. BEN specifications, tools and technical assistance will be available to allow for conversion to a digital library, including a front-end for login and user management, a search engine, browse and search services, and the metadata management tool set.

Societies or owners of the resources retain the rights and responsibility for managing and ensuring the quality of their resources and metadata. Currently for resources and metadata not properly maintained by the society or the owner, the BEN de-accessioning practice is to delete the record from the BEN catalog. However, once finalized, BEN will follow the NSDL Collection Development Policy, which is currently under development by the NSDL Policy Committee, CI, and Content Standing Committee, in regards to collection maintenance, evaluation of resources, persistence and archiving, and de-accessioning.

2) Providing or Developing Resources, Services, and Software Tools for New BEN Collaborators

Table 3 provides a summary of resources, services or software tools to be developed or provided by BEN Collaborators.

- Eight Collaborators will convert existing e-resources to digital libraries that meet NSDL metadata and technical specifications, including AIBS, BioQUEST, BSA, DNALC, EntDigl, SDB, SICB, and VIDA. This will bring the total of biological sciences digital libraries developed or modified by BEN to 13, including APS, ASM, ASBMB, ESA, and Science's STKE.
- One new collaborator, the National Association of Health Education Partnerships (NAHSEP), and BioLink will catalog, validate, and maintain its metadata and electronic resources. Other Collaborators currently doing this include the American Phytopathological Society, HAPS, ABLE, SOT, BSA, and FUN. This will bring the total of organizations cataloging and maintaining records in digital libraries of BEN Collaborators from 6 to 7, since BSA is now proposing to create its own digital library.

Four of the founding Collaborators, APS, ESA, ASM, and AAAS will mentor new Collaborators and design a professional development workshop and related materials. This workshop will be targeted to Collaborators and others interested in developing, maintaining, and sustaining biological sciences education digital libraries and cataloging resources using NSDL metadata standards and specifications.

Topics to be discussed in the workshop will include: (a) understanding metadata; (b) cataloging existing resources; (c) peer reviewing resources; (d) adding new resources; (e) reviewing and adding new versions of existing resources to the BEN catalog; (f) archiving and preserving resources; (g) managing digital rights and intellectual property; and (h) and sustaining digital libraries and e-resources. Workshop participants will get first hand experience using cataloging and metadata tools and submissions and peer review screens. In addition, we will review materials located at the NSDL community portal and the NSDL.org.

3) Development of a BEN Faculty Campus Representative Program for Increasing Contributors and Users of BEN and the NSDL

In an effort to increase submissions to digital libraries of BEN Collaborators, the BEN collaborative will pilot test a BEN Faculty Campus Representative Program (Faculty Rep). The objective of the Faculty Rep Program is to identify and provide technical assistance to prospective contributor/users of the NSDL BEN Collaborative. To implement this outreach effort, we will identify college and university faculty who are interested in conducting contributor/user workshops for:

- Biological sciences faculty members in their department and other departments on their campus, particularly for faculty who have NSF or other education or research grants.
- Biological sciences faculty in community colleges and high schools in their local areas.
- Biological science educators attending regional professional society meetings.

Starting in year 2 of the Pathways Project and continuing in Years 3 and 4, fifteen BEN Faculty Reps will be selected each of the three years, for a total of 45 Faculty Campus Reps. Selection criteria will give attention to faculty that have experience or responsibilities for conducting biological sciences education professional development workshops for college and university faculty or high school biological sciences educators.

We are particular interested in identifying faculty that have NSF or NIH grants for biological sciences education materials development or for professional development of high school teachers or college and university faculty. In selection for Faculty Reps, attention will be given to balancing biological sciences sub-disciplines, race/ethnicity, gender, disability, and Carnegie Classification of Colleges.

Applicants will be required to write a short outreach plan that indicates how they will implement the contributor/users workshops and technical assistance on their campuses and in their nearby communities. Workshop objectives will focus on increasing Faculty Reps understanding of: (a) what metadata is and how it is used in a digital library and portal; (b) how to use existing digital library resources to enhance teaching and learning; (c) how existing resources within BEN are reviewed for content accuracy; (d) how to contribute materials to a digital library collection and how this can enhance faculty teaching and careers; (e) issues related to digital rights and intellectual property in digital library collections; and (f) how to conduct faculty development workshops on using and contributing to digital libraries.

Faculty Reps will receive a $500 stipend, including $250 after they complete the workshop and $250 after they have filed their first annual report. Reports must include disaggregated data on faculty participating in workshops and contributing resources to BEN and the NSDL. Data will be disaggregated by STEM discipline, gender within race/ethnicity, college type, and a note will be included to report the number of persons with disabilities. Other incentives to sustain participation of Faculty Reps will include annual announcements of the names of Faculty Reps with photos at the BEN portal site and in *Science* magazine. In addition, letters will be sent to Department Chairs or Deans. Such recognition could be used in faculty tenure and promotion packages.

Faculty Reps will be provided with a professional development workshop on the BEN Collaborative, NSDL, and will get hands-on experience using the submission and cataloging tools, metadata validation tools, and peer review screens. In addition, participants will be introduced to NSDL.org and digital library resources. Guidelines and materials will be developed for the BEN Campus representatives.

We envision that campus and community contributors/users workshop sessions will require two hours or less and that these hands-on workshops will be embedded in professional development activities conducted by departments or colleges of sciences or high schools. Workshops can be incorporated into regular faculty or high school educator professional development activities and into departmental meetings or retreats. We expect that individuals attending the sessions will bring materials to be submitted to the workshop. In addition, these workshop participants will be introduced to BEN and NSDL.

We expect each Faculty Rep to provide hands-on experience for at least 20 biological sciences educators in colleges and universities and high schools. In addition, we will produce a demonstration CD ROM for use in professional meetings. We expect each Faculty Rep to present two demonstrations per year on how to submit a resource. We estimate that these approaches will involve more than 2,700 biological sciences educators in professional development activities that will increase the use of BEN and other NSDL resources.

The annual professional development workshop for all Faculty Reps will be held on a college or university campus. In addition to conducting the Faculty Rep workshop on campuses, we will also host a second workshop for contributors who are ready to submit resources to the sites of BEN Collaborators. The Faculty Rep Program and related materials will be developed by ASM, APS, and AAAS.

C. Summary of Products and Dissemination

By the end of the proposed 4-year cooperative agreement, we expect to increase the number of peer-reviewed, harvested-biological sciences resources contributed by Collaborators to the BEN

portal and the NSDL from nearly 3,700 to over 27,000. With funding from this cooperative agreement, we will develop a professional development workshop, using technical standards and specifications and tools already developed by the BEN Collaborative, for professional societies or coalitions interested in developing digital libraries or partnering with an existing digital library or portal. By the end of this proposed project 13 professional societies will have digital libraries that meet NSDL specifications and another 9 societies or coalitions will be contributing resources to the NSDL through digital libraries of the BEN Collaborators.

In addition, we will also develop a professional development workshop and related materials, including a demonstration CD ROM, for Faculty Campus Representatives. By the end of this proposed project, 45 college and univesirty faculty members, geographically dispersed around the US, will be prepared to provide campus and community-based workshops and technical assistance in selected areas for an estimated 2,700 prospective contributors to BEN and the NSDL, as well as users of these resources.

Table 3 --- Summary of Collaborators, Number and Types of New Resources to be Provided or Developed by BEN Collaborators for this Cooperative Agreement

Collaborators	Number of New Resources	Resources Types	Services or Resources to be Developed or Provided
AAAS ***Science Online*** ***Science's* SAGE KE** ***Science's* STKE** **SB&F** **Science NetLinks**	 **2,100** **2,500** **400**	 **Articles** **Perspectives** **Reviews** **Reviews** **Lesson Plans**	**BEN Portal Operations, Maintenance and Site Redesign** **Cataloging, validating, and maintaining electronic resources and metadata** **Development and implementation of Professional Development (PD) Workshops and related materials** **Development of the Faculty Rep Program and materials** **Mentoring new Collaborators**
AIBS	**200**	**Articles and lesson plans (English and Spanish language)**	**Cataloging e-resources to a digital library** **Development and implementation of PD Workshops and materials**
APS	**1,200**	**Lessons and labs, journal articles, graphics, and images, including about 250 K-12 lessons and resources**	**Mentoring of Physiology related Collaborators, including SDB and NAHSEP** **Development and implementation of PD Workshops and materials, including online PD workshop**

			Development of the Faculty Rep Program
ASM	**800**	**Visual resources, lessons and labs, journal articles, and reviews**	**Development and implementation of PD Workshops and materials** **Development of the Faculty Rep Program**
BioQuest Curriculum Consortium	**500**	**Simulations, tools, investigative case-based learning modules, databases, exercises, articles**	**Converting e-resources to a digital library**
Botanical Society of America (BSA)	**6,015**	**Annotated Images, lab exercises, abstracts**	**Converting e-resources to a digital library**
DNALC	**200** **5,000**	**Multimedia units, activities, lesson plans, laboratories** **Animations, video, photographs, flat art**	**Converting e-resources to a digital library**
Ecological Society of America (ESA)	**800**		**Mentoring of Ecological Groups/Materials**
Entomology Digital Library	**400**	**Lesson Plans, Experiments**	**Converting e-resources to a digital library**
NAHSEP	**1,000**	**Lesson Plans**	**Cataloging, validating, and maintaining electronic resources and metadata**
Society for Developmental Biology (SDB)	**2,000**	**Lesson plans, articles, Presentations, links**	**Converting e-resources to a digital library**
Society for Integrative and Comparative Biology (SICB)	**80**	**Problem sets, sample course syllabi, demonstrations**	**Converting e-resources to a digital library**
VIDA	**3,500**	**Image sets**	**Converting e-resources to a digital library**
Other Collaborators	**800**	**Lesson plans, images, articles, reviews, connections maps**	**Cataloging, validating, and maintaining electronic resources and metadata**

V. Future Directions and Sustainability

Cycles 1 and 2 of the BEN Collaborative NSDL funding, were primarily devoted to the development of the portal site and digital collections of Collaborators. After Cycle 2 is completed in September 2005, we expect to have enough resources and contributors/users to focus on research studies related to digital libraries and undergraduate biology teaching and learning. Other sources of funds will be sought for these evaluation and research studies.

In addition to seeking NSDL funding, the BEN Collaborators are exploring sustainability issues, including exploring online subscription fees to learning objects, university access fees, fees for services, banner advertising, government/corporate/foundation support, and e-commerce marketplace for educational products. For example, *Science's* STKE launched a subscription plan and generated revenues for about a third of its operating costs and ASM launched a subscription model for the Microbe Library in January 2005 and over 200 subscribers have signed up as of April 2005.

For long-term sustainability the BEN Collaborative goal is to design and develop education digital library collections that are valued by the members of professional societies, thereby eventually ensuring inclusion in the ongoing operating budgets of societies. In most cases, education digital libraries are linked to existing education journals or draw educational e-resources from research journals. BEN Collaborators indicate that internal spending for digital libraries and e-resources is about $1.38 million dollars (See Summary in facilities section).

Features such as author cataloging, online review and commentary, and BEN hardware/software buying power have the potential to reduce the cost of digital library maintenance. Also, we know that for now it is important to keep the cost to users free or low, since we must build the site and build demand for services that the site provides.

VI. Evaluation

In a BEN User Survey conducted in September 2004, five hundred and fifteen (515) responses were returned within a three-week timeframe, representing a 14% return rate. This survey indicated that users include not only postsecondary educators – the primary target audience for the portal – but also a sizeable group of researchers and K-12 teachers. BEN users found the portal primarily through links from other websites, but also via their own web searches, and through referrals from articles and colleagues. They came to the portal primarily to find lecture resources and to enhance their own teaching and learning but they also sought resources for student assignments and non-lecture presentations.

In addition, the users accessed all the BEN partner sites almost equally, offering a first indicator that the BEN goal of promoting interdisciplinary aspects of life science teaching is being realized. Most importantly, the BEN users found what they sought…they downloaded and used resources in their teaching or research and they incorporated new ideas and thinking into their teaching. The users expressed how important it was to find resources that were peer-reviewed and backed by professional societies. Finally, the BEN library helped build the professional community, with users sharing information about and/or sending colleagues and students to the BEN site, and expressing interest in participating in BEN as a contributor and/or reviewer. The full user survey report is in the Facilities section of this proposal.

Evaluation of the NSDL BEN Pathways Project will focus on the specific objectives listed in the Plan of Action. It is important to note that the BEN Collaborative is also exploring the impacts that the BEN resources have on teaching and learning in individual classrooms. However, these aspects of the overall BEN evaluation plan are being carried out under separate initiatives of both the BEN portal and collaborating partners (see progress report above and partner updates in Facilities section); the current proposal does not seek funding for this aspect of the overall BEN evaluation plan.

Documentation of participation, products produced, and items catalogued will, obviously, constitute a large portion of the evaluation data. However, documentation of the process used to provide training and technical support for new and continuing BEN Collaborators will be a critical part of the evaluation and will provide the information needed to develop the "how to" manual that will accompany workshop and training materials for wider dissemination.

In addition to tracking data on number of participants in workshops conducted by Faculty Reps, data for formative and summative evaluation of the Faculty Rep and faculty development workshops will be gathered via entry, exit, and follow-up surveys. To facilitate this process, an

online survey site (e.g., HostedSurvey.com or SurveyMonkey.com) will be used. Several of the BEN Partners have extensive experience in using these online services with both large and small groups and in methods to encourage adequate response rates to follow-up surveys. In addition, discussions via BEN Faculty Rep and faculty development bulletin boards will be analyzed for depth of conversation and content of discussions.

Finally, bulletin board discussions, entry/exit/follow-up surveys and focus groups will provide evaluation data for BEN Collaborator workshop and development activities. All instruments and methods developed for the evaluation will be available at the BEN site for use by other NSDL and faculty development projects. Evaluation for the collaborator development and the Faculty Rep program will be conducted by Marsha Matyas, APS and Yolanda George, AAAS.

VII. Interoperations with the NSDL CI

Since the inception of the NSF NSDL Program, BEN Collaborators have been active members of the NSDL community. For the last 3 years, BEN Collaborators have participated in the NSDL governance and standing committees that are developing metadata and collection policies and future directions for the NSDL community Yolanda George served for 3 years on the NSDL Policy Committee. Other BEN Collaborators serve on the (a) Community Services Committee - Amy Chang (ASM), Co-chair; (b) Educational Impact and Evaluation Committee - Jason Taylor (ESA); (c) Technology Committee - Linda Akli (AAAS) and Cal Collins (AAAS technical contractor); and the (d) Sustainability Committee – Linda Akli (AAAS) and Amy Chang (ASM).

BEN Collaborators, including AAAS, ASBMB, ASM, and ESA presented posters at the NSDL 2003 and 2004 PI/PD meetings. In addition, BEN Collaborators presented in workshops at the 2003 and 2004 NSDL PI/PD meeting, including workshops on metadata, evaluation, and sustainability. Also, Paul Craig and Tim Driscoll, ASBMB BioMoleculesAlive, attended The NSDL Reusability workshop in Orlando, Florida in February 2004 and Amy Chang, ASM, attended the Council on Library and Information Resources and National Science Digital Library on "Digital Libraries and the Humanities" in April 2003. BEN Collaborators will continue to serve as active members of NSDL committees.

In August 2003, the BEN portal site upgraded the original implementation of OAI to Version 2 as required by NSDL CI for metadata harvesting. The checklist recommended by the NSDL CI was followed, and the BEN portal site OAI server passed validation by both the OAI and NSDL OAI validator programs in September 2003. BEN e-resources are expected to be harvested by the NSDL in May 2005. Also, as already mentioned, the metadata specification and other documentation are publicly available at the BEN portal site. In addition, we continue to add documentation and reports to this site. http://www.biosciednet.org/project_site/

VIII. Management, Staffing, and Timeline

The PI for the BEN Pathways CA is Yolanda George (AAAS) and she will serve as the liaison with the NSDL CI. Co-PIs include Marsha Matyas (APS), Jason Taylor (ESA), and Yulu Xia (EntDigl). Collaborators will manage subcontracts for work listed in Table 3. Summaries of work to be done by Collaborators with the name of the lead contact are included in the Facilities section of this proposal.. AAAS will develop agreements and deliverable dates with lead contacts. Collaborators will manage subcontracts in accordance with their organizational policies and governance structures.

Since AAAS has fiduciary responsibility, Yolanda George and Shirley Malcom will be responsible for ensuring high quality work performance. An administrative coordinator will support the work of the BEN and day-to-day communications and assist with work related to the development and implementation of the Collaborators and Faculty Rep professional development components. Linda Akli, the BEN Project Manager, the AAAS EHR Web Master, and staff from the AAAS Technical Services Department will spearhead search engine and portal site upgrades, support, maintenance, and redesign. The site redesign is primarily to update the look of the site. The subcontractor for portal and harvester upgrades, support, and administrative support e-guana.net -- http://www.e-guana.net/ has worked with BEN since its inception and has been an active member in the NSDL community.

Table 4 includes the timeline with tasks and groups responsible for those tasks. More information about plans, duties and responsibilities can be found in the budget or facilities sections of the proposal.

Table 4 --- Timeline and Groups Responsible for Tasks

Tasks	Year 1	Year 2	Year 3	Year 4
Converting e-resources to digital libraries	AIBS DNALC BSA	BioQUEST SICB SDB VIDA		
Cataloging and validating metadata and maintaining e-resources	All Collaborators	All Collaborators	All Collaborators	All Collaborators
Portal and harvester upgrades	AAAS e-guana.net ASBMB ASM	AAAS e-guana.net ASBMB ASM	AAAS e-guana.net ASBMB ASM	AAAS e-guana.net ASBMB ASM
Portal /harvester support/maintenance	AAAS e-guana.net	AAAS e-guana.net	AAAS e-guana.net	AAAS e-guana.net
Development of PD workshops & materials for Collaborators & Faculty Reps	ASM APS AAAS			
Annual Collaborators Workshop	Coordinating Council	Coordinating Council	Coordinating Council	Coordinating Council
Selection of Faculty Reps & PD Workshops	Coordinating Council	Coordinating Council	Coordinating Council	
Campus contributor workshops & TA		Faculty Reps	Faculty Reps	Faculty Reps
Quarterly Meetings	Coordinating Council	Coordinating Council	Coordinating Council	Coordinating Council
Evaluation and reports	All Collaborators	All Collaborators	All Collaborators	All Collaborators
Summary Reports	AAAS	AAAS	AAAS	AAAS