This column has been a welcome opportunity to keep the *CBE—Life Sciences Education* readership aware of national efforts to improve undergraduate education in the life sciences and of ways to become a part of that effort (Woodin et al. 2009, 2010, 2012; Wei and Woodin, 2011). Throughout the years of engagement in the Vision and Change initiative, from the summer of 2007 to the present, the three primary agencies involved, the National Science Foundation (NSF), the National Institutes of Health (NIH), and the Howard Hughes Medical Institute (HHMI), have continually maintained a dialogue with participants through formal and informal conversations, workshops, and meetings. Our shared focus has been on how the life sciences community itself can change biology undergraduate education in order to better reflect and respond to the current educational environment, including the

- rapid advances in the discipline,
- new educational technologies and platforms becoming available,
- evidence developed through research on effective practices in undergraduate education, and
- challenges of accomplishing the necessary changes with the resources available.

As the participants have talked and the funding agencies have listened, it has become clear that many life sciences faculty and administrators are unaware of existing funding programs and of the strategies needed for writing an educationally related proposal. In this column, we hope to remedy this problem (in part) by making the life sciences audience aware of two NSF programs particularly relevant to Vision and Change that appear to be underutilized by the biology community. These are:

- Transforming Undergraduate Education in Science, Technology, Engineering, and Mathematics (TUES) program (anticipated Spring of 2013 release), and
- Undergraduate Research Coordination Networks—Undergraduate Biology Education (RCN-UBE) program (next deadline is June 14, 2013).

**PROGRAM DESCRIPTIONS**

Both TUES and RCN-UBE support the community to catalyze change within undergraduate biology education and, in effect, act synergistically. TUES supports change in the way courses are taught, development of new materials (including new assessment materials to support these approaches), and research into undergraduate education in general. It offers support at both the course and department levels. TUES funds can be used to support course development by funding faculty time and other resources, including some funds for initial purchase of instrumentation essential to the development and implementation of transformative changes in student laboratories and/or lecture classes. TUES funds also may be used for faculty development activities that prepare other faculty to incorporate these new ideas into their own teaching (NSF, 2006). TUES also supports evaluation, webinars, conferences, and a project information portal (American Association for the Advancement of Science [AAAS], 2011). The current (FY2013) program has tracks ranging from small pilot projects with funding caps of $200,000 to large national projects with funding caps of $6 million.

The RCN-UBE program focuses on forming alliances of faculty, professional societies, and institutions active in developing, among other things, learning in emerging technologies in the biology curriculum, strategies and approaches for
engaging biology faculty in professional development, incorporating emerging subdisciplines into the biology curriculum, improving assessment of student learning, improving the transition of students from 2-yr to 4-yr institutions, and incorporating authentic research experience into undergraduate laboratory courses (NSF, 2012b). The coordination efforts may include holding workshops, generating websites, or other appropriate means of developing a community of practice. The RCN-UBE program has two tracks, a full proposal track that funds projects up to $500,000 and an incubator track that funds projects up to $50,000. The incubator track accepts proposals that request support for the initial development of networks that will catalyze positive changes in biology undergraduate education. About a half-dozen incubator awards have matured into successful full awards. While the number of proposals submitted to the program has declined, the funding rates have remained high (Table 1). (The average funding rate across the 5 yr of the program is 41.8%; this is nearly double the average NSF funding rate [NSF, 2012a].)

A glance at the recently funded projects within these programs (see the Supplemental Material) should help the reader understand the scope of these two programs and how they relate to one another. Principal investigators do not need to have an ongoing project in one program in order to apply to the other, but may apply to both programs, as appropriate.

### Table 1. Yearly distribution of proposals and awards within the RCN-UBE program

<table>
<thead>
<tr>
<th>Fiscal year</th>
<th>Awardeda</th>
<th>Funding rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>3</td>
<td>23%</td>
</tr>
<tr>
<td>2010</td>
<td>12</td>
<td>57%</td>
</tr>
<tr>
<td>2011</td>
<td>7</td>
<td>37%</td>
</tr>
<tr>
<td>2012</td>
<td>1</td>
<td>20%</td>
</tr>
<tr>
<td>2013</td>
<td>5</td>
<td>56%</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>41.8%</td>
</tr>
</tbody>
</table>


### Table 2. Distribution of TUES type 1 proposals submitted during FY 2012 and the number of majors and faculty members in the United States in the STEM disciplines

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Awardeda (% awarded)</th>
<th>Submitted (% submitted)</th>
<th>Graduates per year (% STEM graduates)</th>
<th>Number of facultyb (% STEM faculty)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>18 (10%)</td>
<td>97 (10%)</td>
<td>88,000 (41%)</td>
<td>50,090 (22%)</td>
</tr>
<tr>
<td>Computer science</td>
<td>39 (21%)</td>
<td>176 (17%)</td>
<td>38,000 (18%)</td>
<td>33,510 (14%)</td>
</tr>
<tr>
<td>Chemistry</td>
<td>22 (12%)</td>
<td>116 (12%)</td>
<td>12,000 (5.5%)</td>
<td>20,830 (9%)</td>
</tr>
<tr>
<td>Engineering</td>
<td>48 (26%)</td>
<td>278 (28%)</td>
<td>53,000 (24%)</td>
<td>33,660 (14%)</td>
</tr>
<tr>
<td>Geosciences</td>
<td>11 (6%)</td>
<td>40 (4%)</td>
<td>4,400 (2%)</td>
<td>10,660 (5%)</td>
</tr>
<tr>
<td>Math</td>
<td>17 (9%)</td>
<td>78 (8%)</td>
<td>16,000 (7%)</td>
<td>53,650 (23%)</td>
</tr>
<tr>
<td>Physics and astronomy</td>
<td>12 (6%)</td>
<td>58 (6%)</td>
<td>5,000 (2.3%)</td>
<td>15,710 (7%)</td>
</tr>
<tr>
<td>Interdisciplinary</td>
<td>13 (7%)</td>
<td>122 (12%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Research and assessment</td>
<td>5 (3%)</td>
<td>42 (4%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Total</td>
<td>185</td>
<td>1007</td>
<td>216,400</td>
<td>230,000</td>
</tr>
</tbody>
</table>


to emerge. Designed specifically to develop communities of people who are working on similar projects, but who otherwise may be unaware of others with similar interests, it generated a flurry of proposals in the first 3 yr, but this was followed by a dramatic decrease in the number of submissions. We are hopeful that the increase in the number of proposals between 2011 and 2012 represents an appreciation of the value of this program to build and strengthen current or future collaborative efforts, as well as an awareness of the program within the community. It is certainly a program that can serve a crucial role in the development and dissemination of ideas generated to support the Vision and Change initiative call for action.

PROPOSAL WRITING PRIMER

The number of proposals funded within any program depends not only on the number of proposals submitted but also on the quality of the proposals received. The information below provides some advice on proposal preparation.

Writing a proposal for an educational initiative is essentially the same as writing a research proposal. It is important to:

- be sure the proposal is being submitted to the appropriate program;
- clarify the subject matter to be addressed in the instructional materials or practices;
- establish the evidence for the effectiveness of the instructional practices that the project builds on and intends to adds to;
- describe outcomes from any preliminary work you have done to test the potential of the approach;
- present implementation plans succinctly, so panelists can easily understand them and judge their potential for success;
- state the outcomes expected and how they will be determined and documented; and
- indicate the level of support and/or interest either by colleagues within the department or elsewhere.

Resources exist to help with proposal preparation. For example, to determine whether the project is appropriate for a particular program, read the program solicitation carefully; program officers are always available via email or telephone to answer specific questions. The program solicitation provides the names of program officers associated with the program, as well as links to recent awards. We have included an annotated list of selected recent awards in the Supplemental Material. The evidence base for instructional best practices can be found in journals such as this one, as well as in publications such as Vision and Change in Undergraduate Biology Education: A Call to Action (AAAS, 2011) and Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering (Singer et al., 2012). This literature provides information on instructional best practices that inform the project being proposed and ground it in that research base.

In addition to the TUES and RCN-UBE programs within NSF, there are a variety of other funding opportunities for faculty and students in the life sciences, including the following:

1. The HHMI Science Education Alliance helps “bring good ideas in science education to a broader audience by offering educators models of research-based curricula developed to engage college students in true scientific discovery as early as possible in their academic careers” (www.hhmi.org/grants/sea/index.html).
2. The NIH has internship, scholarship, and fellowship programs for undergraduates (www.training.nih.gov/programs).
3. The NIH Institutional Research and Academic Career Development Awards help postdoctoral students develop teaching skills and pedagogical knowledge as they work with established faculty in minority-serving institutions, with the aim of facilitating the progress of postdoctoral candidates toward research and teaching careers in academia (http://grants.nih.gov/grants/guide/pa-files/PAR-12-245.html).
4. The U.S. Department of Agriculture (USDA) offers different pathway opportunities for students and recent graduates to work in agriculture, science, technology, math, environmental, and management, business, and many other fields. The USDA offers internships to students and recent graduates to help them to excel in their chosen fields (www.dm.usda.gov/employ/student/index.htm).

The biology staff of the Division of Undergraduate Education has compiled a resource for those seeking information on the NSF programs that support improvement of undergraduate education in biology. This document includes helpful information on proposal preparation, insights into the review process, and post-award management. While the information is useful for faculty in any discipline, the examples and advice given are oriented to the needs of biologists. The document is updated in August of each year and can be obtained electronically by contacting Helen Vasaly (hvasaly@nsf.gov). The program officers and staff members at the NSF are looking forward to receiving your TUES and RCN-UBE proposals. Good luck!

ACKNOWLEDGMENTS

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American Association for the Advancement of Science (2011). Vision and Change in Undergraduate Biology Education: A Call to Action, Washington, DC.


National Science Foundation (NSF) (2006). Transforming Undergraduate Education in Science, Technology, Engineering and
APPENDIX

Many innovative and important TUES and RCN-UBE projects have been recently funded. This abbreviated listing of recent awards in the program provides some examples to the community of what is currently being done under the auspices of the two funding programs described, with the aim of encouraging applications. The award numbers allow one to search for these projects online. http://nsf.gov/awardsearch/

1140475 TUES: Toads, Roads, and Nodes: Collaborative Course-Based Research on the Landscape Ecology of Amphibian Populations, David M. Marsh, Washington and Lee University, $112,714: This project links networks of undergraduate ecology and conservation biology courses to study the factors that promote the persistence of amphibian populations at landscape and regional scales. Using existing data from the North American Amphibian Monitoring Program (NAAMP) and satellite imagery from Google Earth, students relate the presence/absence of amphibian species in their own state or region to landscape features such as forest cover, road density, and urbanization.

1140640 TUES: San Diego Biodiversity Project: Integrating Authentic Research and Collaboration into the Biology Curriculum, Heather J. Henter, University of California-San Diego, $160,000: The San Diego Biodiversity Project integrates authentic research into the biology curriculum. Students indentify species in the Scripps Coastal Reserve using molecular techniques, such as DNA sequencing and bioinformatics.
1139893 **TUES: Using Metagenomics to Realize an Education Partnership and Stimulate Curriculum Development**, Christopher R. Smith, Earlham College, $168,739: The primary goal of this project is to increase in-class research using data on the soil bacterial communities present in corn and soy agroecosystems. This data is used to develop a course in bioinformatics, and to develop modules for various courses that span the biology undergraduate curriculum.

1061893 **RCN-UBE Incubator: Transforming Undergraduate Education through Increased Faculty Access to NextGen Sequencing Runs**, Michael Boyle, Juniata College, $49,449: This project creates a regional network of faculty from small colleges to work toward the development of teaching approaches that incorporate unanalyzed, investigator-requested DNA sequencing into research and undergraduate teaching activities. The goal is to form a community of biologists from distinct areas (molecular, environmental, plant, microbial, etc.) who can develop parallel research studies in the scholarship of teaching and learning and in their areas of scientific research.

1248108 **RCN-UBE Incubator: Animated Discussions: Biologists and Visual Artists Foster Learning through Animations**, Susan L. Keen, University of California-Davis, $41,189: The theme of this network is animation as a teaching tool in biology. The quality of interaction in the incubator meeting will inform participants as to whether a network can feasibly be formed. Biological animations are used as a learning tool to model sub-cellular processes, create photo-realistic depictions of events, and simulate conditions where users can vary parameters to compare outcomes. Animations can convey information, allow users to visualize processes they could not otherwise see, or challenge users to explain what they see.
**0840911** **RCN-UBE: Preparing to Prepare the 21st Century Biology Student: Using Scientific Societies as Change Agents for the Introductory Biology Experience**, Gordon E. Uno, University of Oklahoma Norman Campus, $420,228: This project (PTP) uses networking meetings to mobilize leading faculty in undergraduate biology education and to help other faculty in reforming their basic biology courses. It will outline a model of introductory biology experiences, articulate a shared vision of biology education, and build a permanent network that connects individuals. The meetings focus on collaborations with scientific societies as change agents.

**0840946** **RCN-UBE: Open Science: An Education Network in Ethnobiology to Coordinate the Development of a New Culture in the Undergraduate Science Classroom**, Patricia D. Harrison, Botanical Research Institute of Texas, $330,925: This project formed an interdisciplinary network to approach undergraduate biology education through the use of emergent web-based technologies and to facilitate continual exchange of educational techniques, materials, and experiences across institutional and international borders. The focus of this project is to develop curriculum models that engage educators and students in scientific inquiry through ethnobiology.