Chapter 5

Modes and Levels of Support

The potential for interactions between mathematics and biology can be developed only by careful nurturing. Some of the isolated interactions between the two disciplines have been discussed in a limited fashion in the earlier overview. The interactions are occurring because the questions exist and efforts are being made by interdisciplinary collaborations or individuals. But this interaction can be strengthened through attention to the modes and levels of support that will encourage such interactions. Specific recommendations follow.

5.1 Research Support

It is recommended that funds for the support of interdisciplinary research between biological and computational scientists and mathematicians be dramatically increased. Projects could take several forms including the following.

1. Projects involving interdisciplinary research by a single investigator.
2. Interdisciplinary groups of mathematicians, biologists and computational scientists of sizes ranging from two individual investigators to networks of individuals from the different disciplines at different universities.

Related to these projects is the further recommendation that specific guidelines for the review process of such proposals be considered. Databases of reviewer names who have biological, mathematical and computational expertise, or any combination of those skills, should be developed and made available to administrators at all involved federal agencies.

5.2 Infrastructure

It is extremely important that adequate computer facilities and support of such facilities be provided. It is recommended that:

1. Funding for computer facilities and support of those facilities be considered to be intrinsic to all awards made.
2. Funding for clearinghouses for software development, maintenance and distribution be made available.
3. Support be provided for networks for database access and network collaborations.

5.3 Training

Training in this interdisciplinary field must be regarded as a lifelong exercise. It must start early and continue for the professional lifetime of the scientist. Thus, recommendations for such continuing education are made for several levels of training.

5.3.1 Precollege and Undergraduate Education

Children, both in primary and secondary school, have a natural interest in biology. In the past, this has been limited largely to field biology or experiments that are chosen for minimal cost rather than the long range view of building a base for exciting the child into consideration of quantitative biology as a career. While this remains perhaps the most natural avenue for arousing the curiosity of a child about the nature of biology, quantification must be introduced at an earlier stage. This is a natural area to show students projects and group efforts consistent with new mathematics curricula (see Mathematical Sciences Education Board, National Research Council 1990; National Council of Teachers of Mathematics, Commission on Standards for School Mathematics 1989). Few of these applications appear in textbooks, and most are absent entirely from the preparation of teachers. Our recommendations are to:

1. Develop curriculum materials in mathematical biology for grades K through 12 and commit special teacher enhancement funds to introduce these materials to the nation's cadre of teachers.
2. Establish a program of summer internships for high school students and/or undergraduate students in which the students would spend two months working with mathematicians or biologists.
3. Support faculty at undergraduate institutions for training and research experiences that will further their knowledge and interest in the cross-discipline.
4. Support summer workshops developed for high school or undergraduate level faculty or/and students that focus on biological subdisciplines in which mathematics and computation play a large role. Instructors should be recruited from both disciplines. A paradigm might be the Computational Neurobiology Course at Woods Hole, MA.
5. Support workshops and conferences to develop methods for introducing significant quantitative tools to be introduced

naturally into precollege and undergraduate biology curricula.

6. Support graduate students in applied mathematics and/or biology with an interest in the other discipline to work with high school and/or undergraduate students as teaching assistants or in other more imaginative ways to develop the younger students' interest.

5.3.2 Graduate and Postdoctoral Training

The recommendations is this category are designed to improve the quantitative knowledge of biologists, to improve the biological knowledge of mathematicians, to facilitate ongoing collaborations, and to encourage new collaborations.

1. Specifically target a substantial number of graduate fellowships in the biological sciences to individuals with undergraduate degrees in the mathematical or computer sciences or vice versa.
2. Support special cross-disciplinary postdoctoral fellowships that will allow Ph.D.'s in one field to work in the other field.
3. Hold mini-courses, lasting four to eight weeks, in areas where both biological insight and mathematical or computational expertise are needed. Levels would be appropriate for graduate or post-doctoral students in one of the disciplines with more basic information in the cross-discipline.

5.3.3 Senior Established Investigators

It is recognized that established scientists with expertise in biology, mathematics and computational sciences are rare. It thus becomes important, at least initially, to encourage and facilitate efforts by scientists in one discipline to cross over into the other discipline to answer significant questions. Are recommendations are to:

1. Establish special mid-career fellowships for mathematical or computer scientists to join biological teams or individuals to enhance their biological insight and for biologists to work with mathematicians for varying lengths of time.
2. Support special visiting arrangements, both short- and long-term, be supported for scientists from one discipline to work with scientists from the other disciplines to encourage greater insight into the use of mathematics in biology.

5.4 Human Resources

Several federal funding agencies already have a number of programs that encourage and seek out under-represented groups (women, minorities and persons with disabilities) in the sciences. This effort should continue that emphasis. All of the disciplines considered in this initiative have under-representation of minorities and people with disabilities. A significant number of biologists are women, but the number of female mathematicians decreases as the level of the degree increases. It is hoped, that as mathematical biology develops as a field, this statistic will change.

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