

## Anat Yarden

Merav Avrahami Yael Piontkevitz  
Ayelet Baram Varda Shilo  
Gilat Brill  
Yael Eran-Tzoran  
Hedda Falk  
Hadas Gelbart  
Shlomit Hadad  
Ilana Hopfeld  
Einat Mizrahi

# Bridging between the dynamics of biological discoveries and high-school biology education

## Department of Science Teaching

Tel. 972 8 934 3793

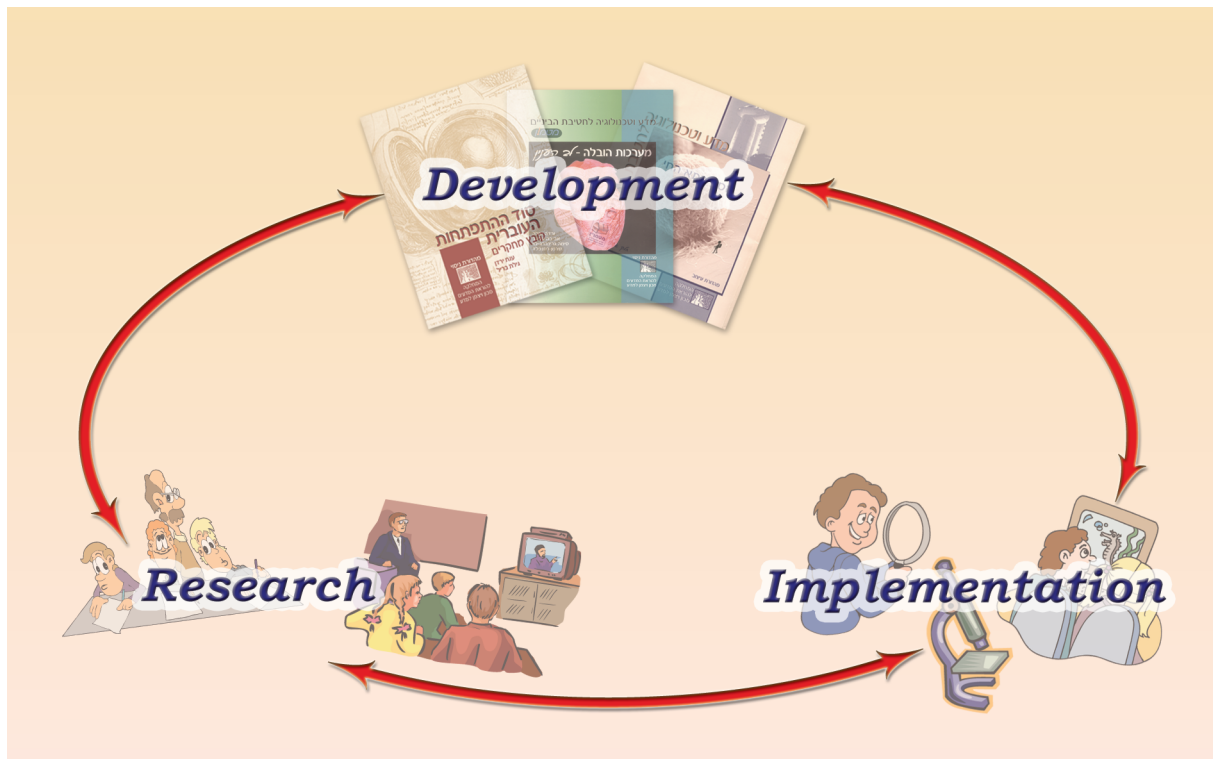
Fax. 972 8 934 4115

E-mail: anat.yarden@weizmann.ac.il

Since biology is the most dynamic research field within the natural sciences, the gap between the accumulated knowledge in biology, and the knowledge that is taught in schools, rapidly increases in time. Our long-term objective is to develop means to bridge between the dynamics of biological discoveries and high-school biology education. Toward this objective we focus our efforts on development and implementation of novel learning materials in biology for the junior- and senior-high school level, as well as on research which is aimed to study the effectiveness of the newly suggested learning strategies. The leading theme in all our activities is our attempt to adopt processes used by the scientific community to the process by which students accumulate and advance their knowledge within the discipline of biology.

### The living cell as a longitudinal axis

Students' difficulties in understanding the microscopic - macroscopic relationships within living organisms are addressed in a new concept we developed and are implementing to teach the topic of the living cell. We suggest to use our newly developed learning materials about the living cell as a central axis in the teaching program in biology, during the entire 3-year period of junior-high school. Our program accompanies all the biological topics studied in junior-high school at the microscopic level, providing the functional cellular explanations of processes studied at the macroscopic level. The program includes: a student text book (*A Journey to the Living Cell*) which provides the very basic concepts and ideas which are required for understanding the topic; a computerized learning environment



**Fig. 1** Development of new learning materials, implementation of those materials and research in the field of biology education, are all dependent on each other and build the framework of our work.

(*A Close Look at the Living Cell*) which provides numerous dynamic visual aids and explanations adjusted to the junior-high school level; and a teacher's portfolio (in preparation) which includes student activities and suggestions of how to incorporate the cellular level into each of the biological topics studied at the macroscopic level.

### Learning biology in an interdisciplinary manner

Our central strategy in developing interdisciplinary learning materials, is to harness the knowledge obtained during the study of scientific principles in the various disciplines, in order to provide the physical and chemical bases of the biological processes under study. In learning materials we developed for the junior-high school level, topics in physics accompany those of biology. For example, basic optical concepts are introduced to explain the mechanism of vision (*Senses and Sensors*) and principles of pressure and pressure differences are used for explaining heart function (*Transport Systems: The Heart of the Matter*). In these learning materials, hands-on technological activities are used for demonstrating mechanisms of action in analogy to the specific biological systems.

### Study through research papers

One of the ways by which we attempt to bridge between the dynamics of biological discoveries and the teaching of biology in high schools is the usage of scientific research papers for a high school biology curriculum (*The Secrets of Embryonic Development: Study Through Research*). We have focused a developmental biology curriculum on four key questions in the field which are presented to the students in a format of scientific research papers, which were adopted especially for the program. Each paper has an internal structure of a scientific paper and presents a key question, the means which were taken to address this question, the conclusions and the new questions which were formulated following the specific research. We have organized these four papers around a central axis, which presents the basic principles of embryonic development and the open questions in the field. We hope this approach will stimulate students' scientific and creative thinking about experimental approaches in current experimental biology. We have also adopted the usage of scientific research papers for a biology teachers development program (entitled: *Biology Teachers Journal-Club*).

### Web-based learning

Current strategies, which are employed by molecular biologists, include intensive use of bioinformatics-related techniques. We have adopted some of these strategies in order to teach high school biology majors basic ideas in genetics. For that purpose we have developed web-based learning material which includes interactive problem-solving activities that are based on the

human-genome databases and search engines. We recently developed another web-based learning environment in Immunology (*An Adventure in the Immune System*), which focuses on the cellular and molecular basis of the normal immune response. This environment, which includes animations, interactive demos, video clips and forums, enables the students to interactively learn while exchanging information with other student colleagues, with the teacher, as well as with experts in the field (e.g., scientists at the Weizmann Institute).

### Selected Publications

- Yarden, A., Brill, G. and Falk, H. (2001). Primary literature as a basis for a high-school biology curriculum. *Journal of Biological Education* 35, 190-195.
- Yarden, A. and Yarden, O. Cooperative class preparation of a problem awareness file promotes meaningful learning among undergraduate students. *Journal of College Science Teaching*, in press.

### Learning materials (in Hebrew)

- Yarden, A. and Bartov, D. (1997). A journey to the living cell. (grades 7-8, 2nd edition 1999, 3rd edition 2001).
- Piontkewitz, Y. and Kedem, O. (1998). Sensors and senses. (grades 8-9, 2nd edition 1999, 3rd edition 2001).
- Ben Zvi-Assaraf, O., Orion, N., Ben-Menachem, O. and Yarden, A. (1998). The blue planet-the water cycle on earth. (grades 8-9, 2nd edition 1999, 3rd edition 2001).
- Yarden, A. and Brill, G. (1999). The secrets of embryonic development: study through research. (grades 10-12, 2nd edition 2000, 3rd edition 2001).
- Zer-Kavod, G. (2000). Let's characterize life. (grades 7-8).
- Shilo, V., Kliger, A., Grinberg-Levy, S. and Rosenfeld, S. (2000). Transport systems: The heart of the matter. (grades 8-9, 2nd edition 2001).
- Yarden, A. and Bartov, D. (2001). A journey to the living cell: an introduction to cell structure and function. A teachers guide.
- Yarden, A., Brill, G., Levine, N., Hadad, S. and Guy, H. (2001). A close look at the living cell: a computerized learning environment. (grades 7-12, developed in collaboration and distributed by the Center for Educational Technology, Tel Aviv).
- Hopfeld, I. and Ben-Zvi, R. (2001). An adventure in the immune system. (a CD-ROM accompanied by an internet site: <http://stwww.weizmann.ac.il/g-bio/immuno2000/>)
- Gelbart, H. and Yarden, A. (2001) Bioinformatics for high-school biology students. (<http://stwww.weizmann.ac.il/bioinformatics/>)

### Acknowledgements

Supported by grants from The Amos de-Shalit Israeli Science Teaching Center.