Michael, D., and Yarden, A. (2007). Genetic engineering: from principles and methods to research and applications (A student text, and an internet site http://stwww.weizmann.ac.il/g-bio/geneengine/animations.html, The Amos de-Shalit Israeli Center for Science Teaching, grades 11-12).

Short summary of the main features

We recently developed learning materials in genetic engineering, which is an obligatory topic within the biotechnology majors' syllabus. The learning materials are comprised of a text for students and an internet site, which outline the main methods practiced in contemporary molecular biology laboratories, alongside with their possible biotechnological applications. We attempted to enable the learners understand the influence of genetic engineering on our lives through understanding the principles, the methods and the applications in both academic research as well as in applied research projects currently carried out in leading laboratories in Israel and around the world.

Even though we do not explicitly deal in the book with the term genetic engineering, we make it clear from the start that the initiation of the genetic engineering revolution is based on recombinant DNA technologies, namely the possibility to form new combinations of DNA molecules in a test tube. Once those new combinations are introduced into cells they can be used for both research and commercial/medical applications. Thus, the use of recombinant DNA enables us to harness cells and organisms for producing products of biotechnological value. The various applications of genetic engineering are widely used in numerous research fields, including cancer research and forensic science.

In the text for students we chose current topics of research and present them alongside their applications, while emphasizing the principles and the methods that make the mentioned applications feasible. The applicative perspective is provided at three main levels:

a. Research applications – for example, the utilization of a cloned gene for over-expression or for silencing of gene expression in cells and organisms, which may enable to elucidate gene function.
b. Diagnostic applications – for example, the use of PCR in genetic diagnosis of Cystic Fibrosis or AIDS, or the use of microarrays for the identification of certain diseases.

c. Biotechnological applications – for example, the production of various drugs in bacteria or in other organisms, or the use of transgenic plants or animals with agricultural value.

Some of the unique features of the student text are:

- A unique illustration serves as a "teaser" at the opening page of each chapter. This teaser is aimed to elicit students' interest in the topic, mainly due to the fact that they are taken from an everyday context that is familiar to the students.
- A historical perspective is provided, outlining the background prior to the discovery of the described method. This is especially emphasized in chapters 2 and 6 in which the discovery of restriction enzymes and the personal story of Kary Mullis, who invented the Polymerase-Chain-Reaction (PCR), are outlined, respectively. This feature is also aimed at eliciting students' interest in the topic, by providing the personal stories behind the important discoveries.
- A longitudinal narrative that can be drawn from all the opening paragraphs of each of the chapters. The narrative that accompanies the book is based on the central dogma in biology, namely the path from gene to function through their historical discoveries and biotechnological applications. This narrative unfolds the processes that are taken to reveal the functions of various genes, while attempting to find new biotechnological applications for their products.
- The figures that accompany the student text are designed to provide sufficient detail required for comprehending the main principles that are outlined in each chapter.
- A short summary appears at the bottom of each page of the student book. Together, these short summaries form a synopsis of the contents of the entire book.
- The questions that accompany each chapter are intended to provide a platform for practicing the content of each chapter in order to reach a better level of comprehension. The questions deal mainly with the most important principles of each chapter.

Taken together, while reading the narrative, the summaries at the bottom of each page, following the figures as well as answering the questions, one can grasp the

main message of each chapter without necessarily reading the main text body of each chapter. We anticipate that this shorter/additional path of learning from the book may assist students with reading difficulties. In addition, the shorter path of learning from this book may assist to ensure full coverage of the required learning material.

The order of the chapters of the student text was chosen according to the chronological order of the discovery of the various methods. We believe that keeping this chronological order is essential for ensuring comprehension of the contents as well as the essence of the progress of scientific discoveries. For example, Kary Mullis could not have invented the PCR without the principles and tools of the Sanger method for sequencing DNA. The various chapters of the student text are outlined below, followed by the main principles that led us in designing the various chapters (Figure 1).

The chapters of the student text are:

1. From molecular genetics to modern biotechnology
   1-A. The basics of molecular genetics
   1-B. Regulation of gene expression
   1-C. From traditional biotechnology to modern biotechnology which is based on genetic engineering
2. Restriction enzymes digestion of DNA and its characterization
   2-A. The discovery of restriction enzymes
   2-B. The power is in the variety: various kinds of restriction enzymes and various kinds of digestions
3. DNA cloning using vectors
   3-A. Plasmids as cloning vectors
   3-B. Simultaneous cloning of several DNA fragments using plasmids
   3-C. Bacteriophage as a cloning vector
4. DNA cloning using libraries and probes
   4-A. Cloning of a cancer gene using a genomic DNA library
   4-B. Cloning using c-DNA libraries
   4-C. Identifying a gene using blotting, hybridization and a probe
   4-D. Various strategies for c-DNA cloning originating from different genes

5. DNA sequencing and manipulating the stored information

   5-A. Determining DNA sequence using the Sanger method

   5-B. From DNA sequence to protein sequence

   5-C. Computerized sequence alignment and reaching conclusions

6. Polymerase-Chain-Reaction (PCR)

   6-A. A unique peek into the inventor's mind

   6-B. The principles and essence of PCR

   6-C. PCR applications

7. Characterization of gene expression

   7-A. Characterization of gene expression at the DNA-level

   7-B. Characterization of gene expression at the RNA-level

   7-C. Characterization of gene expression at the protein-level

8. Engineering of cells and organisms for research and biotechnological applications

   8-A. When recombinant-DNA and money meet: the "birth" of modern biotechnology

   8-B. Over-expression of a gene product in animal cell culture

   8-C. Silencing of gene-expression in animal cells

   8-D. Over-expression of gene product in transgenic animals

   8-E. Genetic engineering in plants

   8-C. From DNA to gene and from gene to function and biotechnological applications

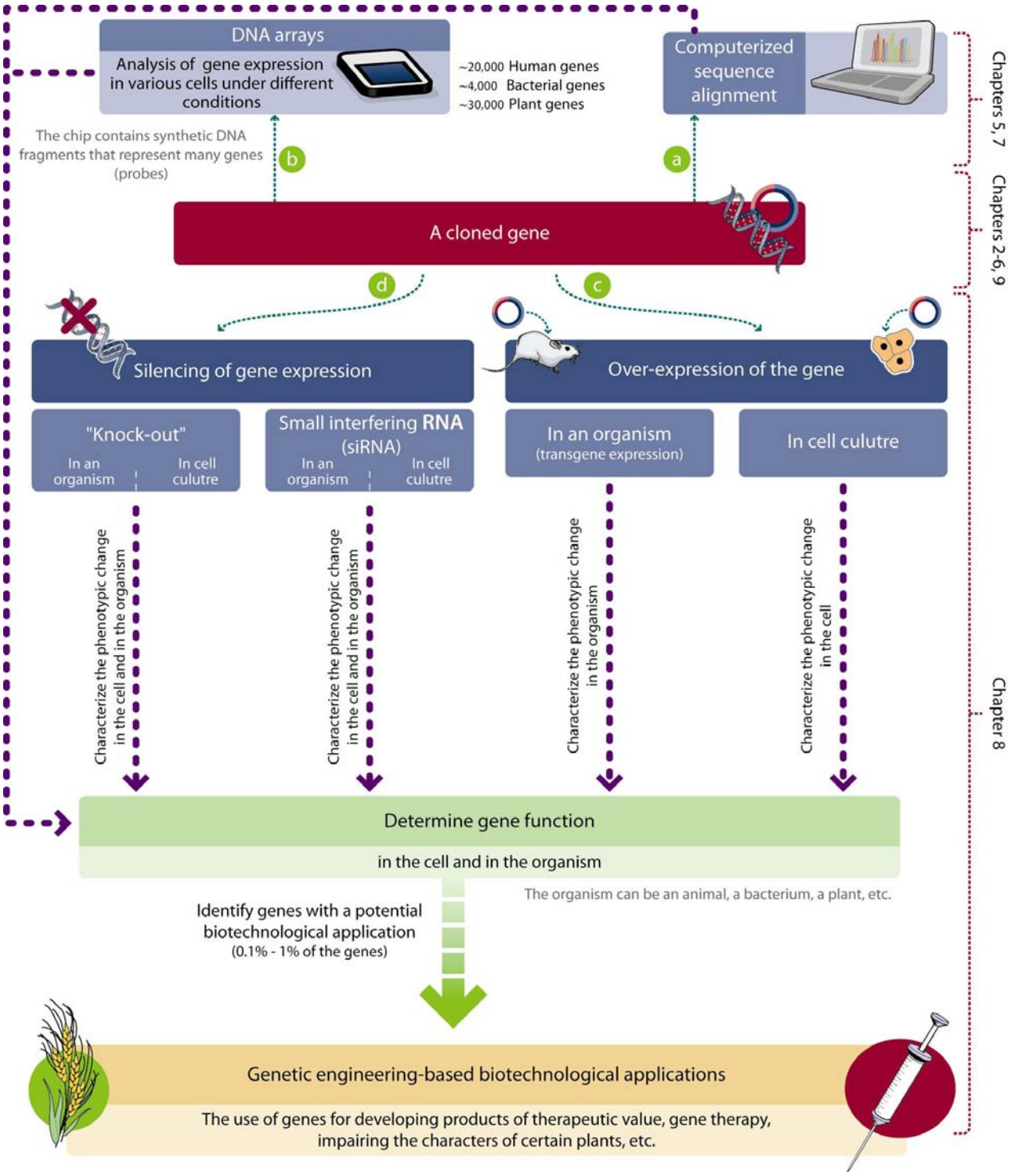

Figure 1. The main principles used for the identification of gene function in cells and organisms. *The organization of the student book is based on the main principles used for the identification of gene function (a-d). This identification is subsequently used in the order used for the identification of genes with potential biotechnological applications (This figure appears as Figure 8-18, page 200, in the student book).*