Abstract

Summary: VIRTLAB is a self-training program based on PBL (Problem-Based-Learning Pathway) built to simulate a molecular biology laboratory. It has been designed to stimulate students in the biological sciences to analyse and solve molecular biology problems using standard laboratory techniques (e.g. restriction enzyme digestions, analytical and preparative agarose gels, DNA cloning and sequencing, etc.) and can thus be viewed as a teaching aid.

Availability: The VIRTLAB package is distributed free of charge to non-profit organisations by the authors (virtlab@biol.dgbm.unina.it). On-line help and tutorials, available now in English, French, Italian, and shortly in German, are provided with the software or at http://biol.dgbm.unina.it:8080/virtlab.html.

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Introduction

Practical training in molecular biology techniques is an important part of the preparation of students in the biological sciences. However, the expense of accommodating and running ‘wet’ labs and the large amount of time needed for standard molecular biology experiments make virtual (‘dry’) labs (Iazzetti and Calogero, 1996) an increasingly attractive alternative in the early phases of student practical training. VIRTLAB is a virtual laboratory of molecular biology based on the Problem-Based-Learning Pathway (PBL) designed to stimulate student-centered and self-directed learning. The PBL approach used in VIRTLAB will help students to feel more comfortable and confident in dealing with the uncertainties and with the multiple challenges of biological problem solving.

Systems, methods and implementation

VIRTLAB is written in Visual Basic 5.0 and has been compiled for PCs running Windows95 and WindowsNT. VIRTLAB has been designed to simulate the basic molecular biology techniques used in a research laboratory (Maniatis et al., 1982): plasmid preparation, digestion with restriction enzymes, analytical and preparative agarose gels, DNA cloning and DNA sequencing. VIRTLAB contains a DNA sequence editor/analysis module that can be used by students for restriction enzyme analysis and DNA translation. VIRTLAB has been built so that each student has his/her own working bench (Figure 1A) and freezer box. Each student has a personal set of restriction enzymes, cloning and expression plasmids (pUC19, pBlueScript, pGEX1λT, etc) and 100 glycerol stocks of E. coli harboring pUC19 plasmids containing cDNAs derived from a Human cDNA library. Examples of the experimental data obtainable using VIRTLAB agarose gel and DNA sequencing modules are shown in Figures 1B and 1C.

Discussion and Conclusion

There are currently sound reasons for using inexpensive microcomputers as an educational resource in Biochemistry, Molecular Biology and Genetics. Although the practical experimental approach remains the most effective method of student training in the biological sciences, some experiments can take days of bench work and cannot be routinely included in basic practical courses. Computerised simulations represent an attractive complement for training of the young researcher (Leach et al., 1997). In addition, virtual simulations can help draw the attention of the students to the relationship between practical bench work and the underlying concepts described in text books. VIRTLAB modules simulate real molecular biology techniques:

The agarose gel electrophoresis module allows separation of fragments generated by restriction enzyme digestions of a plasmid. The DNA bands intensity is dependent on the amount of DNA present in each band. During gel electrophoresis runs the migration of bromo phenol blue dye is simulated by the movement of blue spots through the gel. Gel electrophoresis can be stopped at any time and after evaluation of the bands separation, by UV light, the gel run can be resumed. Moreover, using the preparative agarose gel mod-
Fig. 1. (A) VIRT LAB working bench. (B) Example of experimental data obtainable using the agarose running gel module; the DNA fragments were generated by restriction enzyme digestions (VIRT LAB restriction enzyme module) of pBlueScript plasmid (Stratagene, USA). Up to 7 samples can be loaded on 1% agarose gel; the molecular weight marker used is the 1 kb ladder (Gibco-BRL, USA). (C) Virtual sequencing autoradiography: using virtlab sequencing module plasmid double strand DNA can be sequenced with commercial (e.g. M13 primer, M13 reverse primer) and custom-made primers.

ule DNA band(s) can be isolated from the gel and the DNA present in each band can be used for further digestion or cloning.

The cloning module allows the insertion of a DNA fragment in any of the VIRT LAB available plasmids (e.g. pUC19, pGEX1λT, etc.). When cloning procedure is performed correctly a virtual Petri plate appears on the screen and the number of colonies present on it will be dependent on the total amount of DNA used in the transformation. Students can select 10 colonies from the Petri plate and make mini DNA preparations. Furthermore, the number of plasmids containing the insert is dependent on the insert/plasmid ratio used during the ligation procedure.

Students can obtain general information on the use of the virtual laboratory using the VIRT LAB tutorial available within the program or on our www server (http://biol.dgbm.unina.it:8080/virtlab.html). On-line help and tutorials are currently available in English, French, Italian and shortly in German. In conclusion, VIRT LAB can be considered a starting point for the construction of interactive, complementary teaching tools to help students grasp and master the techniques of molecular biology while stimulating the acquisition of a researchers way of thinking.

References