THE APPLICATIONS OF COMPUTERS IN BIOLOGICAL RESEARCH

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Computers have assisted biological researchers, physicians, and lab technicians since the early 1950s. During the last twenty years computers have become an integral part of research, having acquired a broad range of applications which are useful in many types of research.

Data acquisition is useful in translating electrical signals directly into numerical values. These values are immediately stored in the computer, which also allows the user to go back at a later time to review data from a specific area or as a whole. When data are being taken, the computer continuously scans, identifies, and formats the input data. The computer may also be capable of rejecting irregular data and providing an indication of error. In addition, the computer may automatically calibrate each of the data sources at routine intervals.

Storage and retrieval programs are important assets of the computer because they allow the researcher to maintain a computerized filing system. With the immense quantities of condensed data being collected during even a single research project, a modern computer system is indispensable. During a study, the data can be entered and generated simultaneously. Similar to a manual filing system, the computer files may be kept for any length of time and updated at any time, but the paper files take up a lot of space, are time-consuming to establish, and are much less accessible than computer files.

To eliminate the time-consuming job of manually reducing raw data into readable data, the computer is able to perform the data reductions and transformations for the user. For instance, the results of an electroencephalogram are given as a series of electrical impulses. These impulses influence the stripchart pens, which in turn graphically present the raw data. These data are then reduced and processed by the computer into numerical values sufficient for further study. The computer is especially useful in reproducing images in computerized axial topography. Axial topography is a form of X-ray; however, it differs from the regular X-ray in that it sends the X-rays from head to foot rather than from front to back. The size and complexity of these transformations make it completely impractical to attempt manually.

Another obstacle many researchers previously faced was that of the mathematical computations and operations resulting from their studies. The modern computer can calculate many important physiological variables which may be calculated only indirectly through other variables. More importantly, calculations may be completed during a test or operation enabling the physician or scientist to continue with further tests. Some computers will also inform the operator if a measurement was improperly taken.

An important factor to a researcher is the computer's ability to recognize a pattern. When there have been a lot of data taken, it is important that the computer identify certain amplitudes and intervals. Very often the computer is programmed to

recognize only the most important peaks. In doing this, the researcher is saved days of scanning and analyzing a list of data that would normally take the computer a minute fraction of the time.

Similar to the pattern-recognition function is the process called limit detection. This process also serves to identify specific data; however, the identified data are irregularities rather than the general data a researcher would normally study. A pre-programmed range is designated as normal, and the scientist is warned of any abnormalities in the data. This program would be especially helpful, for example, in monitoring the data from an electrocardiogram or electroencephalogram being conducted along with several studies or even one other study. There would be more time for the researcher to observe other parts of the study and still be informed if something is wrong. In this case too, the data are stored in order to be used later.

Statistical analysis of data is also immensely time-consuming and tedious if attempted by hand. There is also a high risk where errors in calculation are concerned. When large quantities of data have been taken, the statistical analysis function is important not only because it saves the researcher from a lot of manual calculations, but also because it can scan the data itself and help the researcher or physician in finding similarities in the data, which could then lead to finding the cause of an unusual set of data. Statistical analysis by the computer is important even in simple descriptive statistics such as means, standard deviations, and frequency distributions.

One of the more important factors in data analysis, acquisition, processing, etc., is obviously the variety of ways in which it can be presented. There are several different forms which are applicable in most situations such as table printouts, charts, plots, and cathode-ray-tube displays. There are also some programs which sort and organize the data before presenting it in the graph or chart form. Graphs are useful if there is a lot of data that need to be observed in general form; table printouts are useful to the scientist as a quick reference; the charts are helpful for presentation at a meeting or to a boss or supervisor.

A very important asset of modern computers is their ability, when programmed to do so, to actually control the functions of certain laboratory measurement devices. At the same time, they collect and store data from these sources. This is important because it reduces the need to have a crowded operating room or laboratory full of technicians. The scientists are able to concentrate on the actual patient without the added distraction of manually controlling all of the equipment. With these control functions, the computer can also provide feedback to the source of its data. There are programs that regulate the rate, quantity, and/or the concentration of reagents added to a process. A computer can also control the temperature of a temperature bath. It can be programmed to recognize certain results that would indicate possible error. When this occurs, it also has the capability of automatically compensating for some of those sources of error. For more serious errors, the computer would automatically call the error to the operator's attention.

Research in many fields could not be done without computers. There is often a great deal of technical data, even in the biological fields, that need to be analyzed. These data, unfortunately, previously absorbed much of every researcher's time. Now,

due to the steady increase in computer technology, biological research scientists are able to make incredible advances in their work without the added worries of tedious and difficult tasks such as the many mathematical calculations involved in today's research and health care.