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ANIMAL IDENTIFICATION AND DISEASE CONTROL*

by

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**USDA, Office of Scientific Liaison

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ABSTRACT

The application of present day electronic and computer technologies will be a giant step towards the modernization of animal disease control programs. Passive remote electronic animal identification and temperature monitoring; antibody detection and single cell analysis techniques for the detection of infected animals are discussed. Accurate and complete records for epidemiology and for maintaining administrative control over infected herds are made possible by large computer systems. Early and sensitive disease detection with accurate and complete animal identification for traceback are both necessary for disease control. The integration of these techniques into an international animal disease control system is postulated.

INTRODUCTION

As the world demands more optimum use of energy in food production, the application of present day scientific technology to solving agricultural problems will be necessary. With optimum use of the world's energy resources as a prime concern, the conservation of energy in food production is paramount. Efficient food production will be measured not only in optimizing protein for animal and human consumption, but will also be measured in terms of decreased energy requirements.[11] One area of conservation that can be improved is that of disease control in animals. New methods for disease prediction, detection, and forecast need to be developed.

After a diseased animal is detected, its herd of origin and the source of the disease must be determined so that corrective disease control and eradication procedures may be initiated. To determine their herds of origin, animal populations must be identified. Computer technologies must be applied to manage the extensive records that will be necessary for traceback through commerce to herd of origin. Electronic technology offers long-sought solutions for disease detection and epidemiology problems.

APPLICATION OF REMOTE ELECTRONIC IDENTIFICATION AND TEMPERATURE MONITORING

To define uses of the remote, passive electronic identification and temperature monitoring system, we must assume completion of current developmental activity,[5] acceptance by the livestock industry of the need for implanted identifiers, and their subsequent use in domestic animals (Fig. 1). We have also assumed that a network of large computers can be developed to manage the large amount of data that will be generated.

The remote temperature sensing capability provides animal health monitoring capability in all phases of the livestock industry. Although animal temperature fluctuations can be measured when individual animals are monitored,[10] small changes in the average temperature of a large animal population may give an indication of a physiological change associated with disease. Initial temperature profile research at the United States Department of Agriculture's (PIADC) Animal Disease Center in Long Island, New York,[7] showed the potential of using animal temperature histories in the remote detection of foot and mouth disease in deer and cattle. Others have recorded the temperature changes that are associated with changes in feeding metabolism or dairy production. The altered metabolic or physiological activity that is associated with ovulation, parturition, and other disturbances are reflected to some extent in the temperature history of the animal.[1]

The advent of remote, passive temperature monitoring in domestic animals requires a new effort to define exact relationships between physiology and body temperatures. These studies are underway,[10] but much more information is needed.

The potential of the temperature monitoring is summarized in the following paragraphs:

Metabolism - In cattle and swine, adequate intake of nutrients provides for physiological stability in the absence of disease. Prudent use of plant protein in producing meat and dairy products will become more and more critical, and the genetically efficient production animal must be fed exactingly to produce the end product with optimum consumption of plant protein. Temperature monitoring and information from other sources will provide data for computer dispensing of feed and medication. Data from milk analyses and weight gain performances, correlated with temperature monitoring, can provide a high degree of automation with maximum efficiency.

Disease Detection - Animal diseases cause reductions in production efficiency. Often, early disease detection can minimize the effort that is necessary for control of the disease. Many animal diseases cause specific perturbations in temperature histories. These perturbations are related to the multiplication of the infectious organism, and in some instances, can be used for determining the type of organism. The early detection of disease with the subsequent isolation and treatment of suspect animals could result in both large savings to the livestock producers and a more efficient operation. Other recent advances in disease detection will be discussed in following paragraphs.

Other authors have written about the need for a passive (no batteries) subdermal, remote identification and temperature monitoring system for the livestock industry.[3] Its uses in the livestock industry have been logically projected.[4] Now, we must assume that the device is a reality and speculate on its use by the livestock industry.

The system can be used extensively in commerce. In the livestock markets, an animal can be immediately identified upon reaching the facility. The animal's identification number could be transmitted to a large computer center, and verification of ownership could be obtained. If the animal were moved from an infected herd, proper disease control procedures could be initiated.

The animal's temperature could be recorded, and if it were excessive, the animal could be isolated and its cause determined. All animals could be screened using the enzyme labeled antibody (ELA) test that we discuss later. Certain diseased animals could be isolated and consigned to slaughter-only status. If the animal is determined to be free of disease, its sale could proceed normally.

A small computer would necessarily be a part of this system. This computer could be used to automate many of the market operations. Sales transactions, animal weights, seller information, market commissions and buyer information could all be handled by this computer for a rapid and efficient operation. The resulting market data could be transmitted to a large computer facility. There it would be summarized and indexed to provide information to agencies and individuals in need of the information. These data could be used to predict or forecast the world food supply.

The identification and temperature monitoring systems may eventually be developed into three basic configurations: 1) simple hand-held models, 2) a shoulder-harness or back pack model, and 3) permanently mounted models. The hand-held models would be used by individuals to identify animals while the permanently mounted models would be interfaced to a computer and be capable of transmitting data to a large computer center. The latter would be used in larger operations. The portion of these instruments that is used to interrogate the implanted transponder into audio, visual, or electronic data is called the interrogator/receiver, or more concisely, the interrogator.

Hand-held Model

The simple hand-held form of the interrogator would be battery powered and self-contained. This interrogator would provide either audio or visual indication of the animal's ownership. An optional addition to the instrument would be a digital display of animals' temperatures. These units would be coded to an individual herd owner's herd identification number.

Back Pack Model

A portable but more complex system with permanent data recording capability could be designed. The system would be battery powered and carried on the operator's back, similar to a back pack. This unit would be used for recording individual animal temperature and identification. The data would be recorded on a magnetic tape for subsequent transmission to a computer for analysis.

Permanently-mounted Model

The major uses for electronic identification will be found in permanent installations. These systems can be used to control feed mixtures and medication to individual animals, open and close gates (Fig. 2), and assign weight and performance information to the proper animal. The use of these systems in livestock markets has been discussed previously.

These systems can be used to monitor animals as they enter a slaughter plant. The animal identification number will allow traceback to the animal's herd of origin. This information is extremely important if the animal is found to be diseased and disease control procedures are initiated.

Rapid, whole blood disease screening methods such as ELA can be used to further insure the wholesomeness of the final meat product. If an animal is found to be diseased, it is important that the animal be identified for subsequent traceback to the herd of origin.

We expect that these identification systems will be used first in the laboratories and then later will be implemented to automate dairy operations. As they are successful in the above applications their acceptance by the livestock industry should become more wide spread.

OTHER METHODS OF DISEASE DETECTION

Enzyme-Labeled Antibody (ELA) System

A recent cooperative development by the USDA - Animal and Plant Health Inspection Service (APHIS) and by the Energy Research and Development Administration' Los Alamos Scientific Laboratory (LASL) is the ELA test (Fig. 3). This test is being developed for the detection of viral, bacterial, parasitic, and toxin antibodies.[8,9] The test is simple and is easily automated, and will allow for screening single whole blood samples for several diseases. The current test procedure requires 20 to 30 minutes to complete. Up to 96 tests can be done at a time. It is expected that further development of the ELA test will allow for rapid disease screening on ranches, in markets, in slaughter plants (abattoirs), and in laboratories.

The automated ELA system will be computer compatible. Input samples and output results will be correlated by the system with the test results. These results can also be stored on a magnetic tape for subsequent transmission to a large computer center. These data can then be indexed and filed for computer analyses. These data can be used for disease control programs and for livestock prediction and forecast.

Single Cell Analysis

Investigations are currently being made to determine the effects of antigens on cell systems.[2,6] These include the use of the Flow Microfluorometer (FMF) System at the LASL (Fig. 4). Cells are stained with specific fluorescent dyes to indicate a particular cellular property such as DNA, RNA, antigens or antibodies. These cells are passed through a laser beam to excite the flurorescence and the amount of fluorescence is measured electro-optically. The FMF can be used to categorize up to 50,000 single cells per minute. This instrument is being used in the determination of the effects of disease on cells as a function of virulence and to study cell mediated immunity systems.

The latter studies are directed towards a rapid system of determining the pre-immune effects of disease that is evident in cells during the "incubation stages." Certain cellular components of the leucocytic (WBC) series of cells perform the function of antibody production. These antibodies can be detected during later stages of the disease using such methods as the ELA test.

Usually at this later stage of the disease, the animal will have infected several other animals with the disease. The object of these studies is to detect the disease during the "incubation stage" and minimize the probability that the disease is transmitted to other animals.

Diseases such as tuberculosis, which are generally undetectable by current laboratory methods, are of primary concern. Eventually these studies will expand to many important animal diseases, adding a valuable tool to disease control programs.

CONCLUSION

The development and widespread use of an accurate passive livestock identification and temperature monitoring system is the key to the control and subsequent eradication of animal diseases (Fig. 5). This will lead to more efficient food production. With the systems that we have discussed, the livestock industry will be able to better optimize the production of animal protein.

There is an important balance between plant foods for animal and human consumption, animal products and by-products, world human population dynamics, and political and international economic considerations (Fig. 6). All available technology should be used to maintain this delicate balance. New disease detection methods, remote electronic identification and temperature monitoring, and space-age plant-crop assessment, offers the means for maintaining this delicate balance. Further application of scientific technology to agricultural problems is needed.

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FIGURE CAPTIONS

Figure 1. This photo shows the implantable temperature monitoring transponder before and after encapsulation.

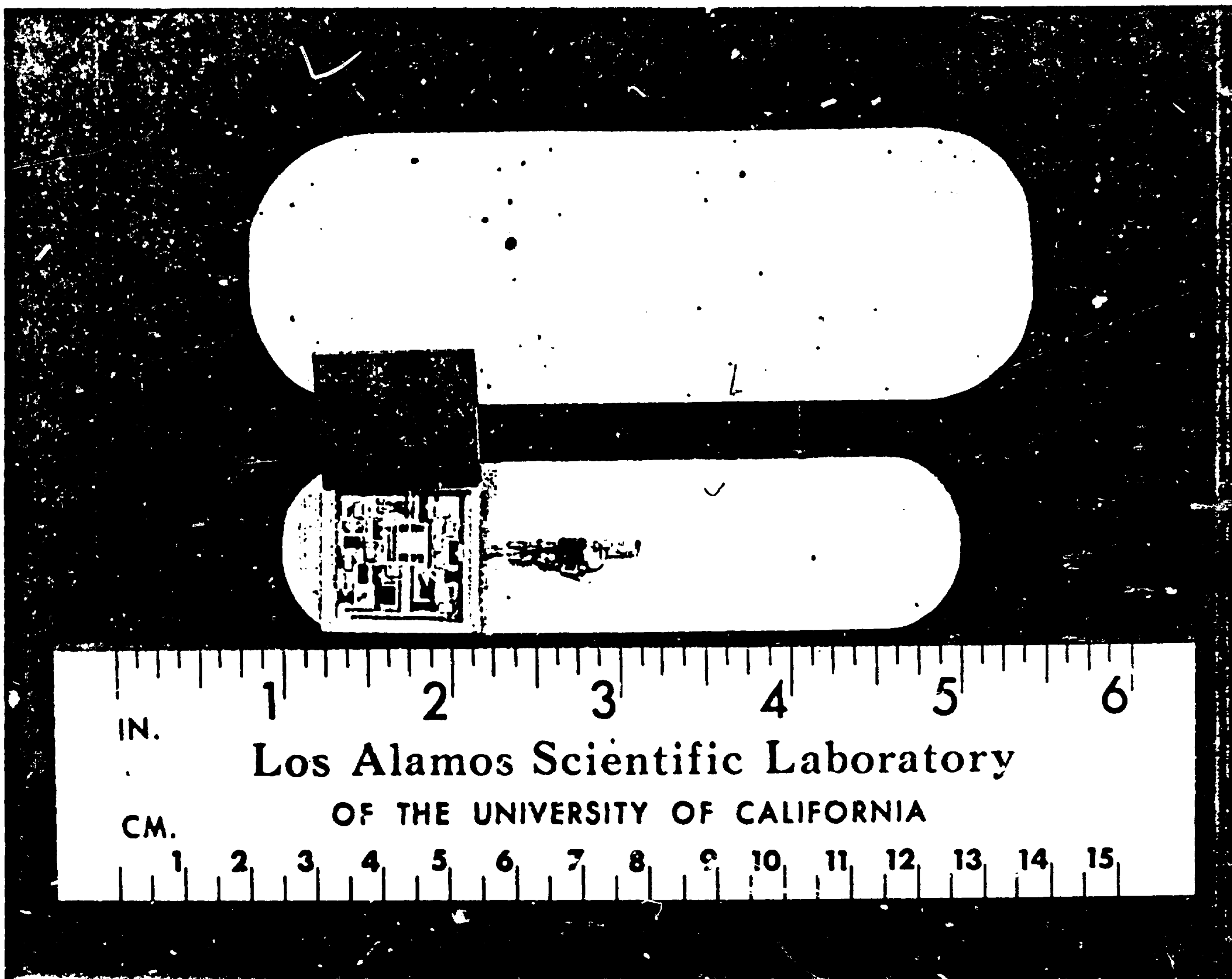
Figure 2. The passive identification system is being used to automatically sort cattle.

Figure 3. The various steps used in the ELA test are shown and discussed.

Figure 4. The principle of the Flow Microfluorometry system is shown.

Figure 5. The animal identification and disease detection systems are shown as they may be used in disease control programs.

Figure 6. The interaction of food and energy supplies are shown.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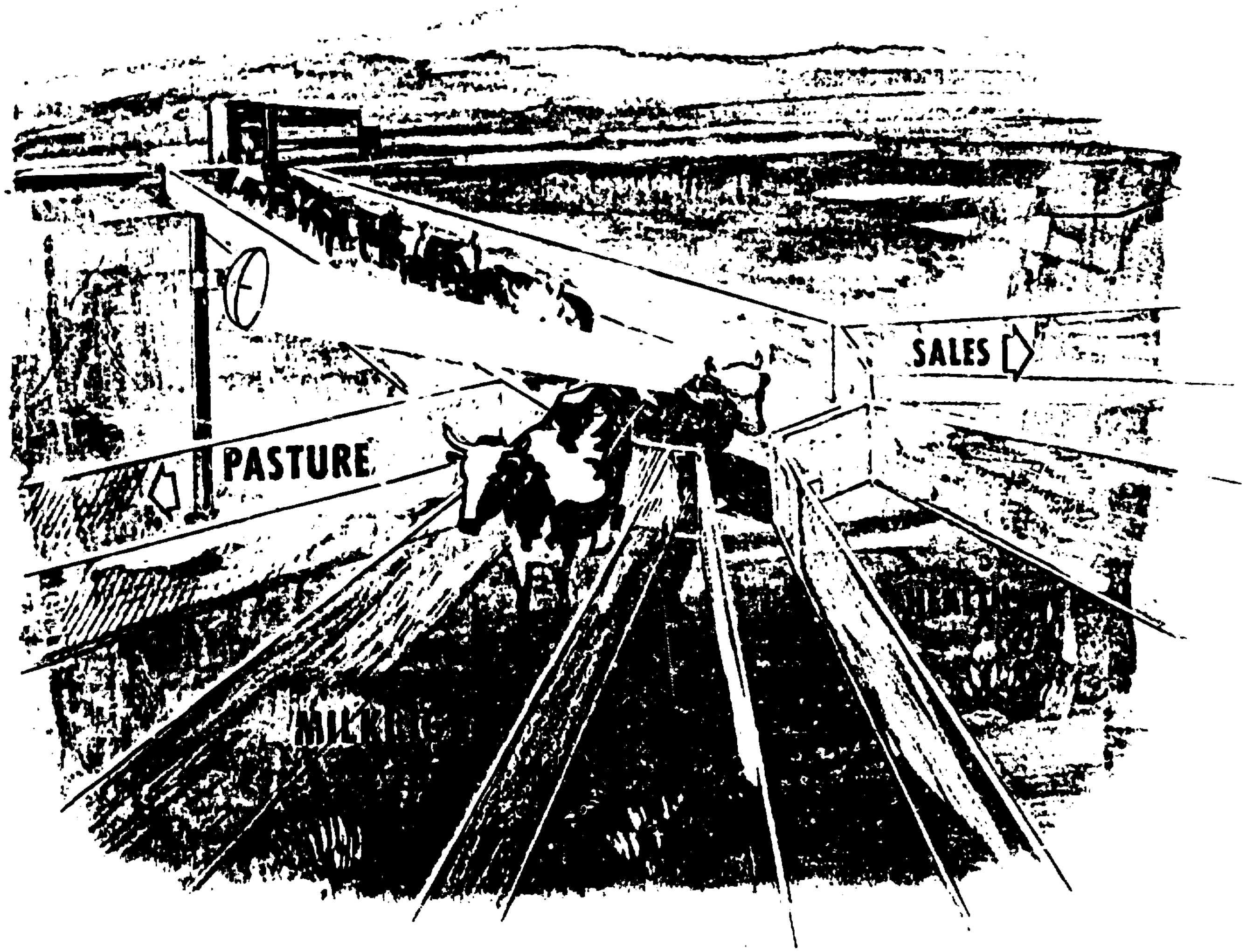
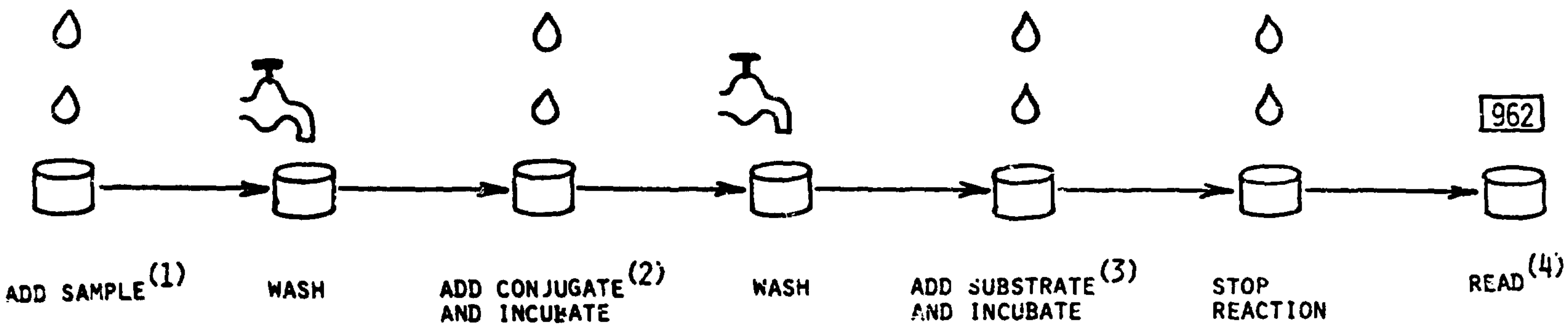

SALES
PASTURE

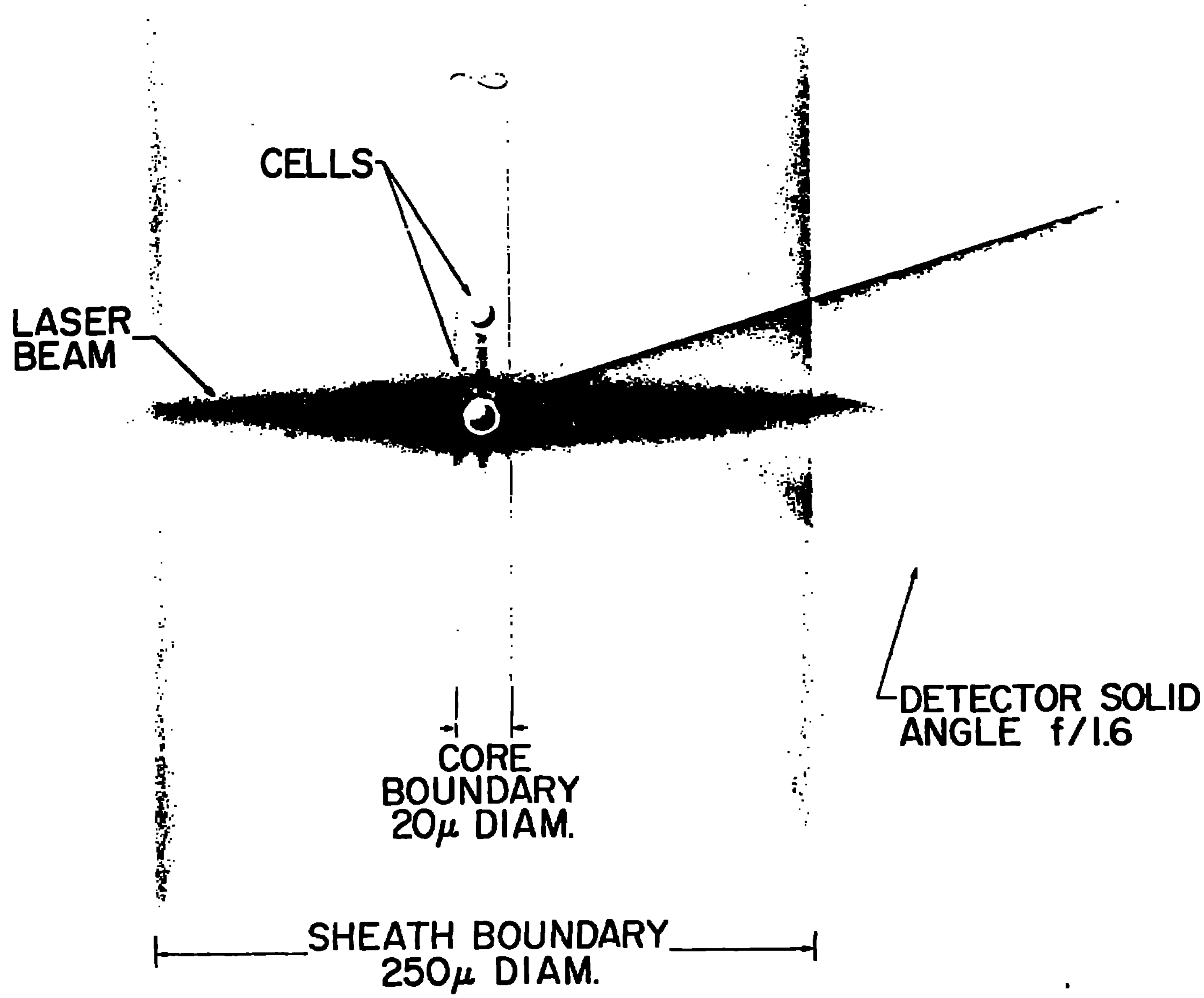
THE ELA TEST

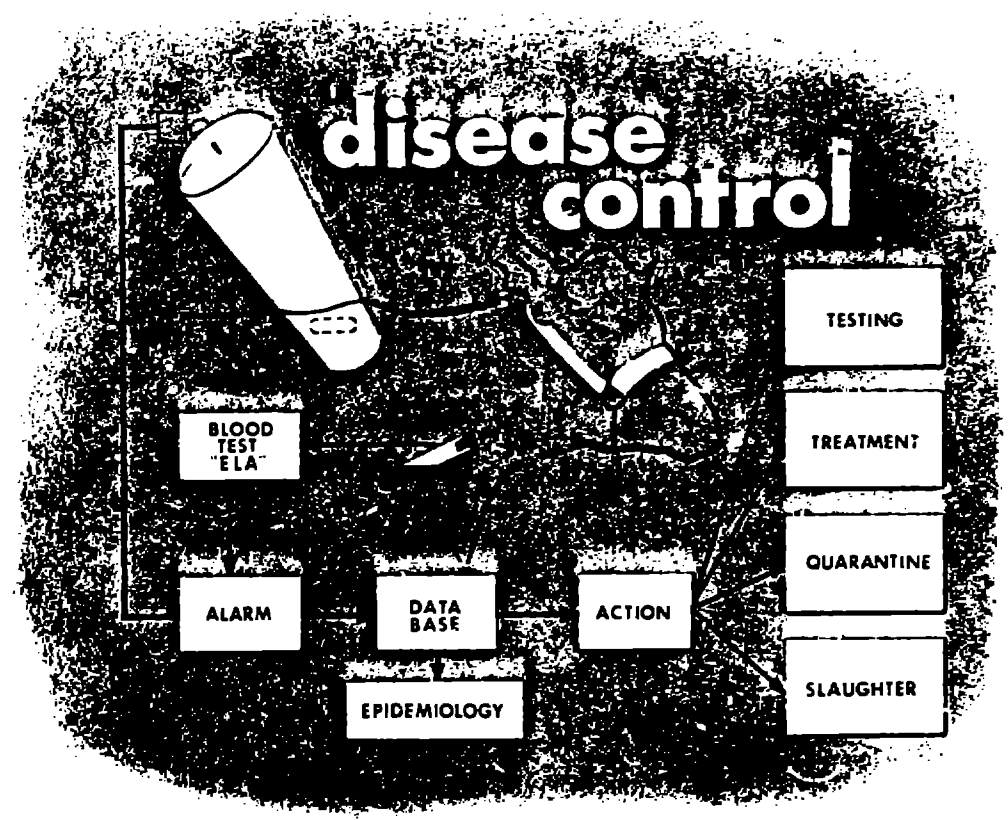
The enzyme-labeled antibody (ELA) test was developed to detect disease by observing the presence of their antibodies in blood. The method is sensitive, fast, inexpensive, and suitable for detecting many different diseases in humans and animals. The test is illustrated below for one disease.

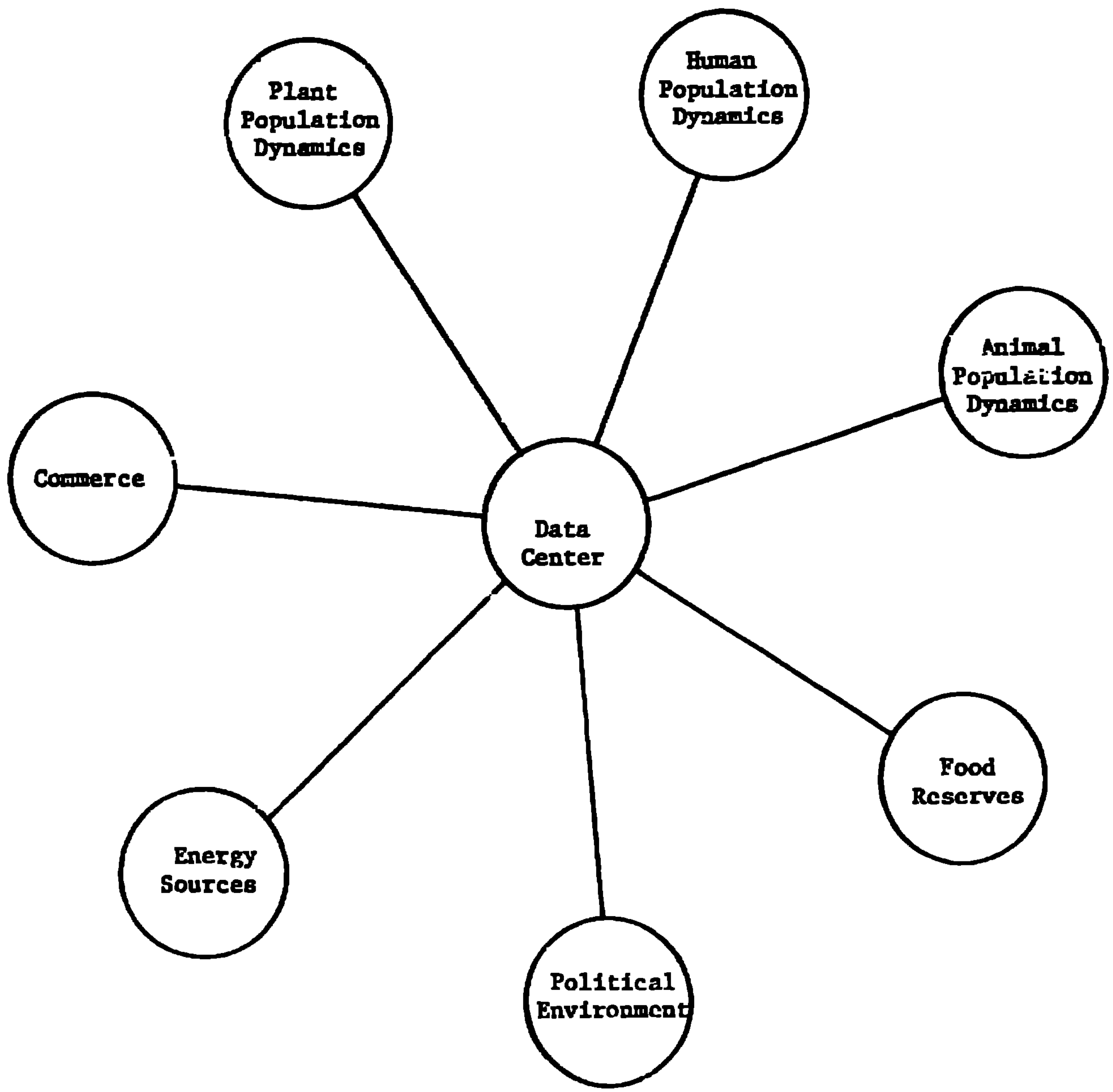


1. Two drops of whole blood or serum are added to an antigen-coated microtiter well.
2. The conjugate is a material that will adhere to an antigen-antibody complex and has "tag" of an enzyme associated with it.
3. The substrate is a material that undergoes a color change in the presence of the enzyme.
4. Negative = clearest liquid
   Positive = darker liquid

The processing can be done in less than 30 minutes at a cost of a few cents per test. Only minor changes in reagents or conditions are required for different diseases or different species. Automation of the processing is underway.


CELLS
LASER BEAM
DETECTOR SOLID ANGLE f/1.6
CORE BOUNDARY 20μ DIAM.
SHEATH BOUNDARY 250μ DIAM.


disease control
BLOOD TEST "E LA"
ALARM
DATA BASE
EPIDEMIOLOGY
ACTION
TESTING
TREATMENT
QUARANTINE
SLAUGHTER



FOOD ASSESSMENT PLAN