# VIDO

1986-87

ANNUAL

REPORT

## The Goals of VIDO

1) To serve the livestock industry through research on the common infectious diseases of farm animals and poultry.
2) To fill the gap between scientific discoveries in the laboratory and their application on the farm.
3) To increase the world's supply of animal protein by reducing loss and wastage from livestock disease.
4) To have higher quality food available to consumers through research on biological (non-residue-forming) vaccines and improved production and management techniques.
5) To improve the public health by reducing diseases that are directly transmissible to man, and, through spin-off of the research of VIDO, to provide better human health products.
6) To reduce the suffering of animals caused by disease.
7) To study the economics of livestock disease.

Veterinary Infectious
Disease Organization

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The Veterinary Infectious Disease Organization (VIDO) was established at the University of Saskatchewan in Saskatoon in 1975. Its initial funding was provided by the Devonian Group of Charitable Foundations of Calgary. Ongoing funding now comes from governments, charitable foundations, the livestock and poultry industries, research grants, contracts and other private sources.

VIDO's mandate is to undertake research that will improve the economic well-being of the livestock and poultry industries by developing new innovative ''natural'' animal health products and improved management techniques.

# Report from the Chairman

B. M. Anderson
Chairman
1986/87

R. M. Murray
Vice-Chairman
1986/87

As VIDO concludes its eleventh year of operation, one could say with assurance that VIDO has gone well past the formative years and is now grown up. This growth is quite evident in VIDO's sphere of operation which includes people, service to the livestock industry, recognition, finances and growth both in personnel and facilities.

The transition from the Directorship of Dr. Chris Bigland to the very capable hands of Dr. Stephen Acres is now well behind us, and Dr. Acres is moving VIDO ahead with confidence and credibility. He, along with Dr. Lorne Babiuk, Paul Hodgman, and Charlene Nicholls-Nixon make up a very good team and certainly this past year's activities and growth would attest to their success.

VIDO is a unique organization in that it has no permanent funding. However, as time has gone by, VIDO now receives funding from the western provincial governments, the livestock industry, federal government contracts and grants and from various research foundations. It has taken a lot of time and effort to establish these funding sources and to keep them in place. VIDO's plan of moving the Board meetings around the country has assisted greatly in telling its story to governments, industries and interested persons. Recently, there has been greater interest and support from Ottawa and this year the Province of Ontario provided its first grant. There is every reason to believe that our support will grow from these areas.

VIDO received much support from the livestock producers and associations in the beginning. The public relations with these groups has been given constant attention by VIDO directors and especially Paul Hodgman all of whom have contributed much to this continuing support.

It seems to me that each year VIDO's recognition from the international scientific field is increasing. Interest shown in our work by the various international research agencies and animal health companies would indicate that we do have first class people and facilities.

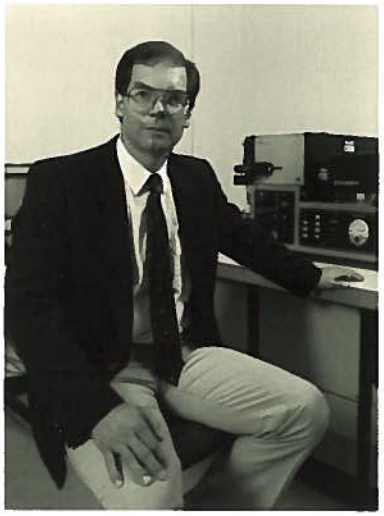
The composition of the Board, which is made up from livestock producers, industry, government and universities makes for an excellent balance to work with the management team. As Chairman, I can state with sincerity that it has been a real privilege to work with such dedicated people as we find in VIDO; not only in the management team but also in the research staff, support groups as well as the Board.

1986-87 has been a good year for VIDO and I believe we can look forward to future growth and service which will give much to the health of the livestock industry of Canada and the world. The challenge will be continued growth and all that this entails.

B.M. Anderson

1987-88 Board of Directors
(Back Row - Left to Right) P.G. Hodgman (Executive Officer), R. Klassen, E. Thiessen, G. Hamilton, R. Christian, S. Kramer, H. Fast
(Front Row - Left to Right) R. Church, R. Murray (Vice-Chairman), B. Anderson (Chairman), S.D. Acres (Director), C.L. Nicholls-Nixon (Manager, Financial Operations), W. Cochrane.
Missing - L.A. Babiuk (Associate Director, Research), R. Bailey, D. Rowlatt.

# Report from the Director



S.D. Acres
DVM, MPVM, PhD
Director

As we have mentioned many times in previous Annual Reports, VIDO was established in 1975 with the objective of doing practical research on the common infectious diseases of food-producing animals and poultry. Some of the practical achievements during the past thirteen years include developing improved diagnostic methods for diseases such as Haemophilus pneumonia in pigs, defining management recommendations to reduce calf scours in beef and dairy herds, publishing detailed information on the design, construction, and management of swine barns, and developing and licensing vaccines for calf scours (Vicogen and Ecolan) and hemorrhagic enteritis of turkeys (Hevlan TC).

These examples illustrate the wide spectrum of expertise and technology required to develop "farm-ready" methods of improving the efficiency of modern livestock production. Just as a farmer requires a number of "tools" such as seed drills, sprayers, swathers, combines and trucks to plant, harvest, and transport a crop to end users, a research organization also requires a variety of "tools" to develop the ideas which will provide future improvements in production efficiency. One of the constant challenges for any research organization is to predict which technical "tools" will lead to the practical solutions that can be applied on the farm. Therefore, at VIDO we take a multifaceted approach to most disease problems with the hope that one or more of them will pay off. Maintaining such a diversified approach creates an ongoing challenge for the Organization because we must develop and maintain technical strength in several areas which will provide the flexibility needed to tackle the economically important disease problems.

## Tools for the Future - Biotechnology and Immunology

The drive to keep VIDO's research "tools" at the forefront demands continual effort because many of the technologies used to study animal disease and productivity have changed dramatically during the past decade. Two of the areas where these changes have been most profound are in the disciplines of biotechnology and immunology.

The revolution in biotechnology occurred because of an evolution in a variety of different disciplines each of which has contributed new information and new tools which allow us to manipulate DNA, the genetic material responsible for heredity. These tools allow us to physiologically, biochemically or genetically manipulate infectious microorganisms and animals, their cells or cell components to produce useful products and services. The ramifications of this for animal agriculture are profound and will lead to changes in many areas of animal production.

The use of new biotechnology products and processes has already started and will accelerate towards the year 2000 A.D. For example, new diagnostic procedures based on monoclonal antibodies and DNA probes are already being used to diagnose a wide variety of infectious diseases and estrus in breeding animals. In some cases diagnostic kits are available which can be used in veterinary clinics or on the farm. Scaled up and automated systems based on the same technology are being used to process hundreds of samples daily in diagnostic laboratories. A new generation of genetically engineered (recombinant DNA) vaccines is also under development. The first vaccine of this type was for neonatal scours and became available several years ago. A second type of recombinant DNA vaccine was licensed for use in the United States last year for the disease called pseudorabies in swine. Fortunately this disease does not occur in Canada and so the vaccine is not used here. However, genetically engineered vaccines for most other important diseases of food-producing species are under development and should reach livestock producers within three to five years.

In addition to vaccines, a variety of other substances used to treat and prevent diseases or to increase production efficiency are now being manufactured by recombinant DNA methods. These include such things as essential amino acids, enzymes, hormones, and lymphokines such as the interferons and interleukins. These will have wide ranging applications in the traditional areas of animal husbandry and veterinary science.

In immunology, the pace of change has been equally dramatic. Whereas 20 years ago it was possible to work in many areas of biology without using immunology, it has now become a fundamental discipline which underlies all biomedical sciences. A major thrust of modern immunology is the development of improved methods to

regulate the immune system (immunoregulation). There is now convincing evidence to show that manipulation of the immune response will not only reduce infectious diseases, but may also provide new ways to improve production efficiency.

The most familiar method of immunoregulation is vaccination against microorganisms, which has been used for over a hundred years to prevent infectious diseases in both animals and man. However, many of the same immunological principles used to develop vaccines for infectious diseases can also be used to immunize animals to regulate physiological functions which control growth, lactation, reproduction efficiency, and carcass quality. One potential approach is to vaccinate an animal against a hormone or a hormone receptor that controls an important physiological parameter. The antibodies which the animal produces following vaccination may neutralize or block the hormone's action which results in a change in some aspect of performance. Growth, lactation, stress adaptation, and carcass characteristics may all be improved by these methods. Because of our expertise in vaccine development and immunology, VIDO is starting to explore some of these new approaches.

A second approach to regulating the immune system is through the use of immunomodulators, compounds that directly influence the immune response. A variety of chemical and biological immunomodulators are now being produced. One of the best known families of immunomodulators are the lymphokines which are substances produced by the white blood cells. These include the interferons, the interleukins, and a variety of immune cell colony stimulating factors. Using recombinant DNA technology, these substances can now be produced relatively cheaply in highly purified form.

Lymphokines have a variety of activities which make them useful in the prevention of infectious dieases including inhibition of viruses and bacteria, and regulation of the immune response. Another potential advantage is that they will provide immediate protection for animals entering high risk situations where traditional vaccines have either not performed well or where it is difficult to vaccinate animals prior to exposure to infection. In addition to their impact on production efficiency, lymphokines are also desirable from the consumers' prospective because they are natural products which do not leave residues or cause toxicities and hence they alleviated many of the concerns about the use of antibiotics and other drugs in animal feeds.

## NSERC - Industry Funding

During the past year, VIDO was fortunate to obtain a major block of funding to explore the use of lymphokines for the prevention of major infectious diseases of food-producing animals. The program is being jointly funded over a five-year period by CIBA-GEIGY CANADA LIMITED of Mississagua, Ontario which provided a $3 million research contract, and the Natural Sciences and Engineering Research Council (NSERC) which provided a matching Cooperative Research and Development Grant of $3.45 million. CIBA-GEIGY will provide recombinant DNA-produced lymphokines and VIDO will determine their effectiveness in preventing and controlling major livestock diseases including shipping fever, pneumonia in pigs, mastitis in dairy cattle and others.

VIDO undertook this major research program for several reasons. One of the main ones is that we wanted Canadian livestock producers to have early access to information and products in this area. While they are still unproven, there is tremendous potential for lymphokines to play a major role in animal production in the future. By carrying out the research and testing on some of these substances in Canada, we hope to ensure that Canadian farmers will be amongst the first to have access to these developments. This will help to keep them internationally competitive. Secondly, collaboration with CIBA-GEIGY gives the Organization access to reagents and techniques needed to remain at the forefront of veterinary immunology. It also brings VIDO's scientists into contact with other researchers around the world who are working to improve production. This helps to strengthen our immunology team which also benefits the research we are doing in other areas of animal health.

It is clear that neither biotechnology nor immunology are simple one-man disciplines. To apply them effectively, teams or groups of researchers are needed. VIDO started building its teams in these disciplines in the early 1980s.

Both groups work in collaboration with each other and with other researchers in all four of VIDO's research programs on neonatal diarrhea, respiratory diseases in beef and dairy cattle, pneumonia of swine, and poultry diseases. In addition, they collaborate with researchers in other units at the University of Saskatchewan and other research centers such as the Biotechnology Research Institute of the National Research Council located in Montreal. The synergy between the various groups has resulted in steady progress on several projects and researchers at VIDO will be testing genetically engineered vaccines for different forms of scours and pneumonia in the next two to three years.

### Animal Husbandry - A Balanced Approach

While VIDO has developed a strength in immunobiology, we recognize that vaccines and other health-care products are not a substitute for good husbandry practices. Therefore, the Organization continues to study animal management, housing and improved husbandry systems. In collaboration with the Animal Health Division of Alberta Agriculture we have helped carry out a large study on monitoring animal health in Alberta feedlots. The study, which involved over 700,000 calves and yearlings, identified and quantitated the impact of a variety of "risk" factors for shipping fever. These included such things as transportation, processing practices, and feedlot management. In addition, the VIDO Swine Technical Group is working on the third in a series of publications on swine building design. Their next publication will focus on feeder barn design and management and will be published during the next year.

### Financial Review

Total revenue for the year exceeded $3,000,000 for the first time in VIDO's history. This dramatic increase ($725,000 over 1986) is directly attributable to the funding provided through the agreements with CIBA-GEIGY CANADA LTD. and NSERC described above. Corresponding increases in expenditures resulted in an excess of income over expenditures of $77,117 for the year. The balance in the VIDO Research Trust fund decreased however, to $1,364,652 as a result of a transfer of $222,255 to the Capital Trust. This transfer was the first appropriation to the Capital Trust for the construction of an additional 10,000 square feet of research facilities as explained in Note 7 to the financial statements.

The increased revenue, expanded facilities and increased staff will require that the Organization continue to monitor expenditures closely to ensure that they are all towards the achievement of clearly defined research goals and objectives.

### Personnel

In much of this report, I have discussed the importance of technology as a "tool" in serving the livestock industry. However, the most important ingredient in research are the people which develop and apply the "tools" to solve economically important problems. The entire staff of VIDO again deserves recognition for their hard work and dedication. Collectively they provide the critical mass of talent and energy needed to tackle complex problems. Individually, each one has contributed to making VIDO a world class research organization.

### Board of Directors

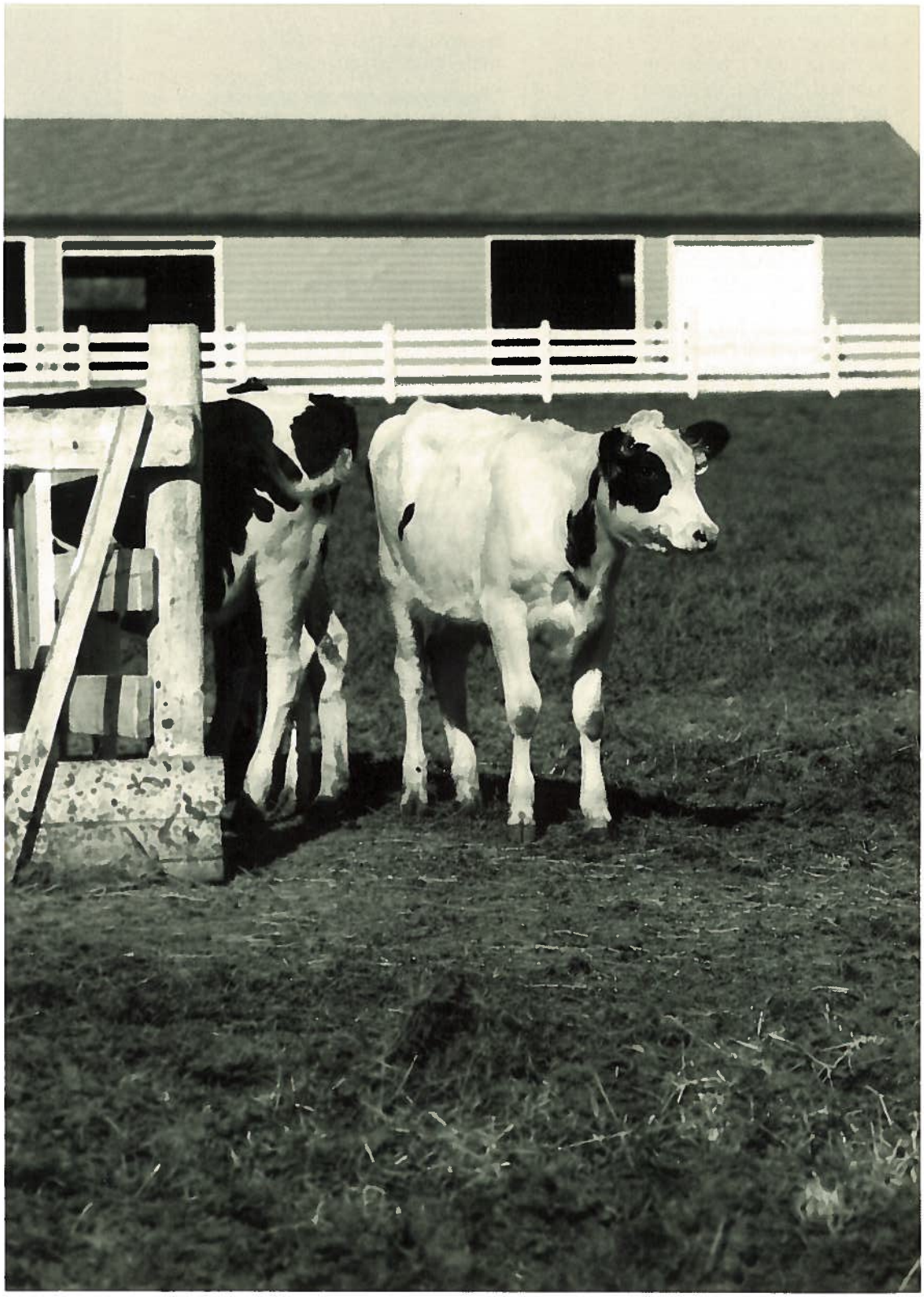
I would also like to express my appreciation to the members of the Board of Directors. Their guidance and counsel to me and the management team has kept the Organization focussed on using our research resources efficiently to serve the livestock and poultry industries. I would especially like to thank the outgoing Chairman, Dr. Boyd Anderson (Fir Mountain, Saskatchewan) who will remain with the Board for another year. I would also like to thank Richard Klassen (Winnipeg, Manitoba) who retires from the Board after four years of service, and to welcome Art Rampton (Dauphin, Manitoba) as a new member. Dr. Ralph Christian has completed one four-year term and has graciously agreed to serve another term on behalf of the Government of Alberta. Dr. Gavin Hamilton, Dean of the Western College of Veterinary Medicine at the University of Saskatchewan, has also agreed to serve another term. I look forward to continuing to work with all members of the Board and the VIDO staff in the future.

Stephen D. Acres

S.D. Acres

C.L. Nicholls-Nixon
B.Comm., MBA, BIOSTAR Inc.
Manager - Financial Operations

*''a major research program aimed at developing methods of preventing and controlling economic losses associated with enzootic pneumonia''*



# Report from The Executive Officer

P.G. Hodgman
Bsc (Agr.)
Executive Officer

## Dairy Cattle Research

After discussions with the dairy industry and information obtained from our Disease Survey, the Board of Directors has instructed VIDO to undertake a research program on behalf of the dairy industry. **Enzootic pneumonia** has been chosen as our new target.

Enzootic pneumonia is a chronic infectious disease which occurs most frequently in housed dairy calves. While death losses can be controlled by the use of antibiotics, many calves suffer permanent lung damage which results in suboptimal performance. Therefore, the greatest economic impact of the disease is through the destruction at an early age of potential herd replacements.

The causes of pneumonia are complex. Although infectious agents are responsible for lung damage which results in poor weight and death in some cases, environment and management factors often predispose to, and increase the severity of outbreaks. The most important predisposing factors are thought to include carrier cows which infect calves at a young age, poor housing conditions, impaired transfer of colostral immunity, and suppression of an active immune response.

With the foresight and financial support from the Saskatchewan Dairy Producers Co-Op and the Manitoba Milk Marketing Board, VIDO started a major research program aimed at developing methods of preventing and controlling economic losses associated with enzootic pneumonia. Since the disease is so complex, and because the role of individual factors has not been clearly defined, this research program is expected to last a minimum of five years.

## Fundraising and Communications

Fundraising is a major activity for VIDO. Our research continues to be supported by the livestock industry, Western Provincial Governments and various granting agencies, both national and provincial. Last year our swine research program which is focused on Haemophilus pneumonia (Actinobacillus), received a significant research grant from the Ontario Ministry of Agriculture and Food (OMAF) through their Pig Improvement Program. The Ministry had received encouragement from the Ontario Pork Producers Marketing Board for this project. The funding complements the continuing contributions from the four Western Pork Boards and Commissions which support a Research Chair in Swine Research.

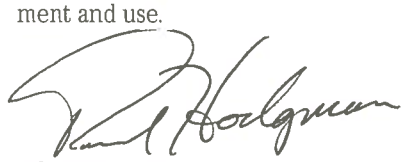
Communications with those who use the results of our research and the financial supporters of VIDO is essential. We continue to meet with and make presentations to various organizations, institutions and governments across Canada. VIDO's Swine Technical Group is preparing the third in a series of technical bulletins on swine production, management and health. This bulletin entitled "Feeder Barn Design and Management" will be printed and distributed in the coming year.

## VIDO Field Station

In last year's Annual Report, we announced the development of the Field Station which was being built to the unique and stringent criteria necessary for doing large animal health research. The Station is now operational, and one annual cycle has been completed. It has provided VIDO with addition capabilities including the following.

1. The ability to conduct research throughout the year. In the past, we were prevented from working during three or four months of the year because of inclement weather.
2. Increased efficiency in the types of experiments that can be carried out. The facilities provide researchers with flexibility and equipment not previously available.
3. The capacity to collaborate with other research institutions, commercial companies, and others.

The Field Station has relieved the pressure on the isolation rooms in the VIDO Laboratory Building and has been an extremely valuable resource for our research. We look to its further development and use.



P.G. Hodgman

*''in the future, many products will be produced by biotechnological means or will have been improved as result of biotechnology''*

# Report from the Associate Director (Research)

L.A. Babiuk
BSA, MSc, PhD
Associate Director (Research)

In the Director's Report, Dr. Acres emphasized using the tools of immunology and biotechnology for developing products for the livestock industry. From his report and much of the lay press, it is evident that these disciplines have the potential to change many of the products which farmers and ranchers use to protect their animals and to improve production efficiency. In the future, many of those products will be produced by biotechnological means or will have been improved as a result of biotechnology. Since several of VIDO's research projects are aimed at developing new or better products, I felt it would be valuable to present an overview of how we can use biotechnology and immunology in this process. During this short description I will illustrate the important steps in developing a vaccine against viral diseases in animals, however there are many other applications of the same "tools".

## Vaccine Development

Many of the vaccines which are now used contain the entire organism which causes the disease in question. In some cases, the organism in the vaccine is living and can cause mild disease in vaccinated animals and can possibly spread to other animals. In other vaccines, the organism has been killed by heat or chemicals and is combined with an adjuvant to increase the immune response. In some cases, these organisms may include components which suppress or interfere with the immune response, which could impair the effectiveness of some vaccines.

To overcome some of these problems, the trend today is towards the use of **subunit vaccines**. These are vaccines which contain only specific components or subunits of the organism which causes the disease. Therefore, they focus the immune response only to the important proteins, while those that may be immunosuppressive are eliminated. Furthermore, they are often cheaper to produce and can be used in conjunction with a diagnostic test to determine levels of protection and whether previous exposure to the organism had occurred. The viral vaccines which VIDO has under development are of the subunit type. Therefore, while biotechnology can be used to develop other kinds of vaccines, this description will focus on subunit products.

In any approach to immunization there are a number of factors which must be considered before an effective vaccine can be developed.

1. **Does infection provide immunity or protection from subsequent infections?** If a previous infection does not provide protection from later infections, then it will be almost impossible to develop a vaccine against that specific disease.
2. **What type of immunity is required?** There are many types of immune responses which can occur within the animal. One type of immunity occurs within the body and is referred to as systemic immunity. Another type of immunity occurs on the surfaces of the body which are directly exposed to infection, such as the airways of the respiratory system or the lining of the intestines. This is referred to as mucosal immunity. In many instances most pathogens enter the body through either the respiratory or the gastrointestinal tract. Many important diseases such as pneumonia, scours, dysentery and pinkeye are the result of these exposed mucosal surfaces becoming infected. Therefore, the first contact which the infectious organisms have with the body is on the mucosal surface. In these instances it is important to develop immunity at the primary site of interaction between the pathogen and the host. Thus, local immunity on the mucosal surfaces is crucial in these instances. In addition, there are two types of immunity: one type involving antibodies is called humoral immunity and the other type involving cells is cellular immunity. Some pathogens are more easily controlled with antibody whereas others cannot be cleared unless cell mediated immunity is produced. Therefore it is obvious that, depending on the specific pathogen, the approach for a vaccine development may be slightly different. However, in this section an overall general scheme of using biotechnology to develop subunit vaccines will be described.

In the development of any subunit vaccine, a number of **"steps"** must be followed. These are summarized in the left hand side of Table 1. The steps are not discrete and may not always occur in the order shown

in the figure. The scientific disciplines or **"research tools"** needed to carry out these steps are shown in the right hand side of Table 1. Their use will be further illustrated in the following text and figures.

**Table 1**
**Subunit Vaccine Development**

| STEPS | RESEARCH TOOLS |
|---|---|
| 1. Identify the cause of the disease (pathogen). | Microbiology |
| 2. Determine whether recovery from infection provides protection from subsequent disease. | Immunology and Epidemiology |
| 3. Identify the virulence factors and protective components which allow the pathogen to cause disease or allow the host to resist infection. | Molecular Biology<br>- Monoclonal Antibodies<br>- Synthetic peptides<br>- Gene assignment |
| 4. Produce the protective component(s). | Biotechnology<br>- Gene Cloning<br>- Gene Expression<br>- Protein Engineering |
| 5. Confirm the protective capacity in host animal. | Immunology<br>- Establish protective capacity of expressed antigens. |
| 6. Formulate vaccine. | |

## Step 1 - Identify the Cause of the Disease

Since the steps in development of any vaccine are similar, the example which I have selected to demonstrate the process of is bovine herpes virus-1. One of the main problems caused by this virus is a respiratory disease called infectious bovine rhinotracheitis (IBR) or rednose, which can occur as a single disease or which can also contribute to some outbreaks of the shipping fever complex. In this particular case, the virus which causes the disease has been isolated and can be grown in tissue culture. The same virus also causes a variety of other clinical diseases in cattle, including abortion in cows, septicemia in newborn calves, and infection of the reproductive organs. Once an animal is infected, it remains infected for life even if it does not show signs of disease. The chronically infected cattle can shed the virus to other animals with which they are in contact. This has important implications for cattle breeders who export their animals to other countries, because most countries will not import cattle which are infected with this virus.

## Step 2

It is also known that once an animal recovers from IBR it will not suffer from clinical disease the next time it is exposed to the virus. This results because the animal has developed high levels of humoral and cellular immunity. Furthermore, there is good mucosal immunity which inhibits virus replication before it gets established. In numerous studies we have found that if the blood serum from an animal can be diluted 16-fold and still neutralize the virus under laboratory conditions, then the animal will be protected from the disease under field conditions. Since animals which recover from the disease are immune to subsequent exposure, it will be possible to prevent the disease by vaccination. Thus, steps 1 and 2 are well established for this virus.

## Step 3 - Identify the Virulence Factors and Protective Components

IBR virus is made up of approximately 40 different proteins or subunits. Some of these proteins are important in maintaining the structure of the virus, others in replication of the virus, and only a very few are involved in attachment to the host cell and initiation of infection.

The two or three proteins that are involved in starting the infection are often the ones that are also important in stimulating the animal's immune system to develop protection needed to prevent infection or aid in the recovery once infection occurs. If these specific proteins could be identified they could be used as a **subunit vaccine**. The subunit vaccine would contain only the protective proteins and none of the other virus proteins which may interfere with the development of a protective immune response.

Our approach to identifying the important proteins of the virus required the use of **monoclonal antibodies**. Following injection of a protein or a virus into an animal, the animal produces a whole variety of different types of antibody. Each specific antibody is produced by one cell, and that cell produces only one protein of the virus and more specifically to only one region of the protein. Following exposure to IBR virus, many cells will produce antibody against each of the 40 different proteins and regions of the proteins. Thus, the antibody found in the serum of animals exposed to the virus is called polyclonal (many clones) and interacts with all the virus proteins. Therefore, it is difficult to use this serum for identification of specific proteins. However, it is possible to isolate one cell which is producing a specific antibody for a protein or a region of a protein. This antibody is called a monoclonal antibody, since it is produced by one (mono) cell, and all the antibody molecules are identical and therefore will only interact with one protein. An example of a production of monoclonal antibody is presented in Figure 1.

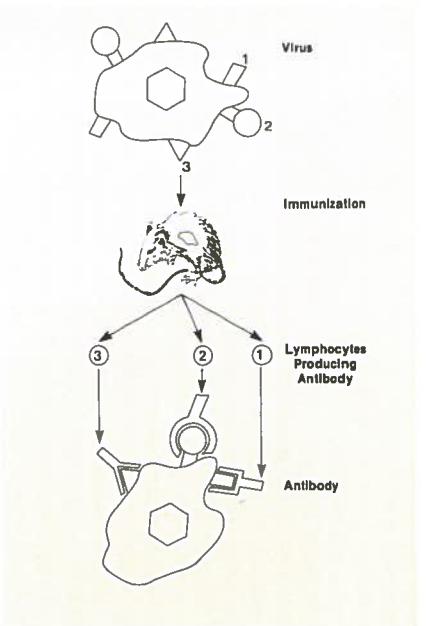



*Figure 1.* Production of monoclonal antibodies - Upon exposure to a virus an animal produces various types of antibodies directed at different proteins (1, 2, 3) of the virus. The specific cells (lymphocytes) producing a single type of antibody can be isolated and cultured. These cells will produce only one type (mono) of antibody directed at 1 protein.

It is possible to produce large quantities of this individual monoclonal antibody and identify the specific protein to which it attaches. If a monoclonal antibody against a specific protein can neutralize the virus i.e. prevent infection, then one can assume that the specific protein is important in inducing protective immunity in the animal. However, to prove this it is necessary to go further and actually show that the protein to which the monoclonal antibody is directed can stimulate protective immunity when injected into an animal. Thus, some proteins may only be partially protective whereas others may be much more so. In order to demonstrate that the proteins to which the monoclonal antibodies are directed are protective, it is necessary to purify large amounts of the protein. This can also be done by using the monoclonal antibody. As demonstrated in Figure 2, the antibody is first bound to a solid matrix (immunosorbent column) through which all the virus proteins are perculated. Those proteins that are not recognized by the antibody are washed away from the column. The only proteins that remain on the column are those which interact with the antibody. Using various methods it is then possible to remove the protein bound to the column as one pure fraction.

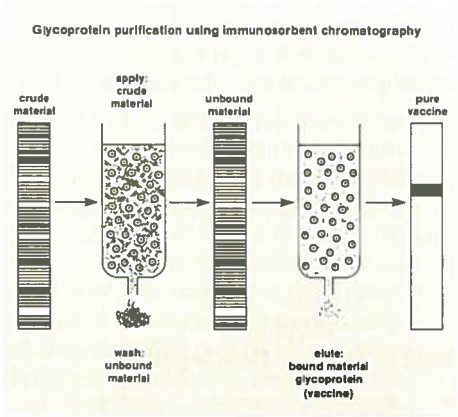



*Figure 2.* Glycoprotein purification - a crude preparation containing all the proteins of a virus are passed through a column to which one type of antibody (monoclonal) is bound. The proteins that don't interact with the antibody are washed out leaving only the one protein attached to the column. This protein can then be removed and used as a vaccine.

This pure protein is in essence a subunit of the virus which can then be injected into animals and tested for its ability to induce antibodies and protection against disease. Using this approach we have clearly indicated that three individual proteins of IBR virus are capable of inducing much higher levels of antibody and better protection than a vaccine containing the whole virus (Figure 3). One reason for this difference in protection is that some of the proteins of IBR virus may damage the immune system and therefore interfere with development of adequate immunity. Secondly, it is very difficult to economically produce large quantities of the virus by standard methods, therefore some conventional vaccines may not contain enough virus to stimulate high levels of immunity.

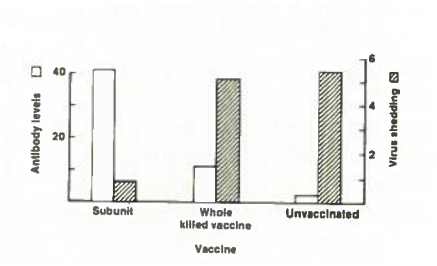



*Figure 3.* Comparison of subunit vaccines with whole killed virus vaccine in protecting calves from IBR - Antibody levels of subunit vaccine were much higher than from the killed vaccine and this correlated with higher levels of protection from disease.

## Step 4 - Produce the Protection Components

At this point in development, we have shown that the natural protein produced by the virus are protective. The next step is to use biotechnology to produce these proteins in large amounts.

a) *Gene Assignment and Cloning and Expression* - Once a specific protective protein is identified it is possible to identify the gene within the virus which produces that specific protein. The procedures that are used to identify these genes are the foundations of genetic engineering and are illustrated in Figure 4. Each pathogen contains a large number of genes within its genetic material (DNA). Each gene is responsible for producing a specific

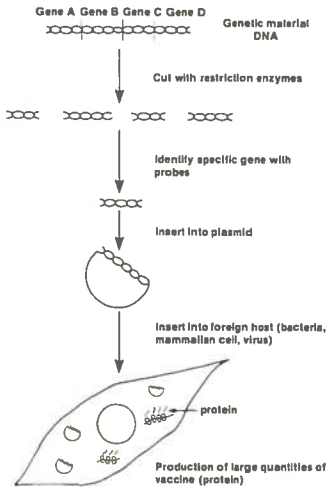



*Figure 4.* Schematic diagram of cloning and expression of proteins for vaccine production. Each organism has many individual genes within its genetic information. Each gene is responsible for producing a single protein. These genes can be identified and cut out with chemical "scissors" called restriction enzymes. They can then be "taped" back into another piece of DNA (plasmid) which is then inserted into another cell which acts like a "xerox" machine to produce large quantities of the protein which is then purified and used as a vaccine.

protein. One of the major tasks of molecular biologists is to find the location of the gene coding for the specific protein which is desired. This is done by a number of different approaches but they are all based on the fact that it is possible to cut DNA into small pieces and identify which piece is responsible for producing each individual protein.

The DNA can be chemically cut with a series of specific enzymes (restriction endonucleases) which act as "scissors" by cutting genes at very specific places. These pieces of DNA can then be purified and chemically inserted back into another piece of DNA (plasmid) with other enzymes (ligases) which act similar to "scotch tape" by sticking the new gene into the foreign DNA molecule. This new recombinant gene (containing DNA from two sources) can be incorporated into a foreign host (cell) which can be grown in large quantities in fermentors. Hence, the new cell acts as a "xerox" machine to produce many copies of the gene which in turn produces large quantities of the recombinant DNA protein. This process is referred to as "expression" of the foreign gene.

## Step 5 - Confirm Protection in the Host Animal

At this stage it is essential to test whether the recombinant DNA protein protects against the disease when used as a vaccine, just as the natural protein did. In some cases the proteins produced by recombinant DNA technology may not have the same structure as the natural protein, even though they are composed of the same building blocks. This occurs because the foreign host cell does not fold the protein or add sugars to the proteins properly. If this is the case, then protein engineering must be used to properly configure the protein so it will induce protective immunity. This can involve testing a variety of forms of the recombinant DNA protein for its protective capacity.

In the above example, the protein is produced biologically by a cell. However, in some cases, it is also possible to chemically synthesize vaccines which are protective. To do this, one must not only identify the proteins which induce protection but also the actual region of the protein which is responsible for this function. Once this is done the small portion (peptide) of the protein can be chemically synthesized in the laboratory from the individual amino acid building blocks and used as a vaccine.

## Step 6 - Formulate Vaccine

Proteins by themselves are generally not capable of producing very high immune responses. Therefore, regardless of the type of vaccine developed, whether it be recombinant DNA produced protein, synthetic peptides or conventional killed vaccines, they must be mixed with other compounds which help enhance the animal's ability to produce protective immunity to the vaccine. These compounds are called adjuvants. Unfortunately very few adjuvants used in experimental animals can be used in food-producing animals since they cause undesirable side effects. Therefore, a great deal of research is aimed at trying to identify better ways of delivering and enhancing immunity to vaccines. In each instance it is important to identify the quantity of protein that is required to be mixed with different types of adjuvants to produce the desired immune response. This immune response may include inducing mucosal immunity or systemic immunity. Some of these adjuvants include purified components of bacterial cell walls, oil emulsions and other chemicals. For each vaccine it is important to formulate the protein and the adjuvant in the proper way so as to maximize the level of protection with the vaccine.

The stage of development of five of the vaccines which VIDO has under development is shown in Table 2. In future reports, we will up-date progress towards completion.

**Table 2.**
**Stage of Vaccine Development**

| Step In Development | Respiratory Disease of Cattle | Neonatal Diarrhea | Porcine Pneumonia |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | Pasteurella haemolytica | Coronavirus | Haemophilus (Actinobacillus) |
| | | Rotavirus | |
| 4 | IBR (BHV-1) | | |
| 5 | | | |
| 6 | | | |

## Application of Lymphokines in Disease Prevention

Another area of investigation, separate from vaccine development, is the natural enhancement of immunity in animals. In the development of an effective immune response, there are a series of complex interactions between the different white blood cells in the body. In order to be able to function effectively, the individual white cells must communicate with each other so that they may assist each other in the overall immune response. These different types of white cells communicate through soluble mediators of proteins produced by one white cell which effect the function of another white cell. These mediators or proteins are called lymphokines.

Lymphokines can be used in conjunction with vaccines to up-regulate or enhance immune responses to the vaccines and thereby act as adjuvants (see above), or they may actually be used in disease situations to help the animal recover from an initial infection. During the past few years, we have concentrated on the application of lymphokines in the reduction of bovine respiratory disease. In these studies we have shown that administration of interferon to cattle exposed to some of the causes of shipping fever can dramatically enhance the animal's ability to recover from this disease. We are now expanding this area of investigation to include other recombinant DNA produced lymphokines of cattle and pigs in the hopes of being able to use these lymphokines to either prevent or treat important respiratory and enteric infections. The advantage of these naturally produced lymphokines over antibiotics for the control of infectious diseases is that they use the animal's own natural compounds to enhance its ability to fight off infections. In this way there are no residues in the meat. Furthermore there is very limited opportunity for the infectious pathogens to become resistant to the lymphokines as is often the case with antibiotics.

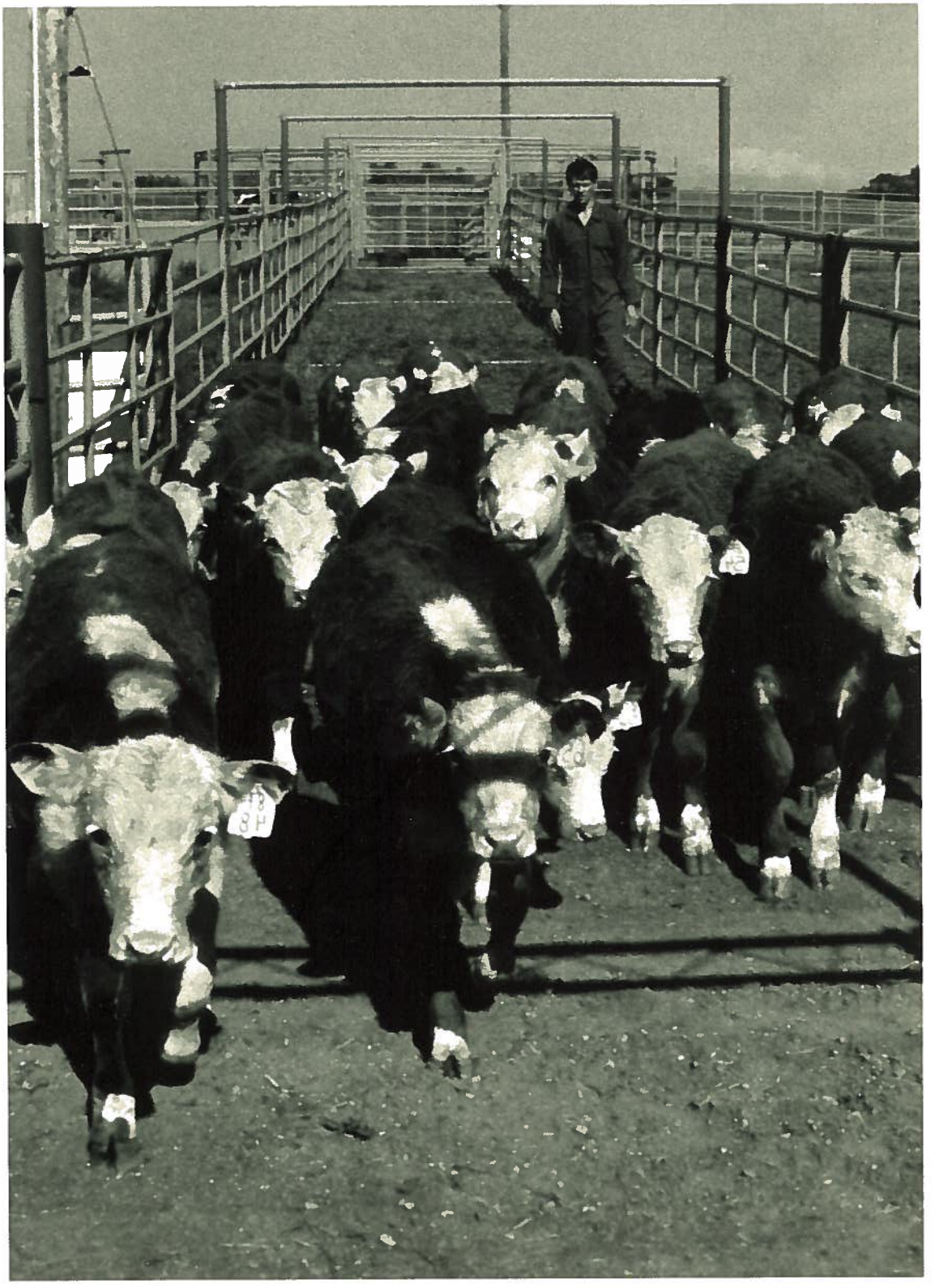
## Summary

As described above, it is evident that we are capitalizing on the recent advances of genetic engineering and immunobiology to be able to produce more effective ways of preventing or treating a number of the common infectious diseases of livestock. We feel that the combination of molecular biology and immunobiology has a tremendous potential for improving the efficiency of livestock production and thereby improving the financial returns to the producer. Although many of the approaches presently being used take a considerable amount of effort and financial resources, we feel that such approaches are essential in the improvement of existing, and development of, new vaccines. Although these procedures are expensive and time consuming, require sophisticated equipment and dedicated employees, VIDO has recruited such individuals to be able to assist us in this endeavour. I feel that we have built a solid foundation on which many of the projects which we have initiated will come to a successful conclusion in the near future.

In closing, I would like to extend my thanks to the dedication of all the individuals working at VIDO who have made this past year an extremely successful one. Secondly I would also like to thank the numerous organizations who have shared in the vision of VIDO and provided us with financial support to continue the exciting research which has been done in the past year. Without this financial support and the dedication of the VIDO staff, none of the achievements of the past year or the future achievements would be possible.

L.A. Babiuk

*''lymphokines can be used in conjunction with vaccines to up-regulate or enhance immune responses''*



# Auditor's Report

*To the Board of Directors of the Veterinary Infectious Disease Organization (V.I.D.O.), University of Saskatchewan:*

*We have examined the combined balance sheet of the University of Saskatchewan - Veterinary Infectious Disease Organization for the year ended September 30, 1987 and the statements of income, expenditure and unexpended funds (Research Trust and Capital Trust) and of changes in financial position for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests and other procedures as we considered necessary in the circumstances, except as explained in the following paragraph.*

*In common with many non-profit organizations, the Organization derives part of its income in the form of grants and donations the completeness of which is not susceptible to satisfactory audit verification. Accordingly, our verification of revenues from these sources was limited to the amounts recorded in the records of the Organization and we were not able to determine whether any adjustments might be necessary to grants and donations revenue, excess of income over expenditure, assets and unexpended funds.*

*In our opinion, except for the effect of adjustments, if any, which we might have determined to be necessary had we been able to satisfy ourselves concerning the completeness of the grants and donations referred to in the preceding paragraph, these financial statements present fairly the financial position of the University of Saskatchewan - Veterinary Infectious Disease Organization as at September 30, 1987 and the results of its operations and the changes in its financial position for the year then ended in accordance with accounting policies described in Note 1 applied on a basis consistent with that of the preceding year.*

Deloitte Haskins & Sells

*Chartered Accountants*
*December 18, 1987*
*Saskatoon, Saskatchewan*

# Financial Statements

University of Saskatchewan
Veterinary Infectious Disease Organization (V.I.D.O.)

## RESEARCH TRUST - Statement of Income, Expenditure and Unexpended Funds

Year Ended September 30, 1987

| | 1987 | 1986 (restated) |
|---|---|---|
| INCOME | | |
| Grants and donations | | |
| Livestock industry - general | $ 177,500 | $ 122,699 |
| - swine research chair | 97,413 | 73,538 |
| Provincial governments | | |
| - Alberta | 100,000 | 100,000 |
| - British Columbia | 5,500 | 15,000 |
| - Manitoba | 15,500 | 15,500 |
| - Saskatchewan-general | 300,000 | 300,906 |
| National Research Council (NRC) | 101,249 | 202,898 |
| Saskatchewan Agricultural Research Fund | 14,500 | 14,500 |
| Agricultural Research Council of Alberta - "Farming for the Future" - Schedule 1 | - | 216,290 |
| Natural Sciences and Engineering Research Council of Canada (NSERC) | 242,200 | 160,155 |
| Industrial Research Chairs - NSERC | 185,200 | 185,200 |
| - BIOSTAR Inc. | 45,483 | 46,252 |
| Kahanoff Foundation | - | 150,000 |
| Other individuals, companies and foundations | 3,969 | - |
| | 1,288,514 | 1,602,938 |
| Contracts | | |
| Research - Schedule 1 | 1,455,775 | 464,043 |
| Services | 32,725 | 43,993 |
| Royalties | 42,289 | 36,768 |
| Interest | 143,345 | 127,415 |
| Animal services | 30,184 | 52,258 |
| Licensing agreement | 65,000 | - |
| Miscellaneous | 28,899 | 34,103 |
| | 3,086,731 | 2,361,518 |
| EXPENDITURE | | |
| Salaries and fringe benefits | 1,116,117 | 1,047,500 |
| Material and supplies | 468,932 | 382,232 |
| Animal services | 146,303 | 167,999 |
| Equipment | 634,981 | 210,964 |
| Travel | 114,532 | 94,557 |
| Facilities and improvements | 175,547 | - |
| Other (Note 3) | 353,202 | 239,772 |
| | 3,009,614 | 2,143,024 |
| EXCESS OF INCOME OVER EXPENDITURE | 77,117 | 218,494 |
| UNEXPENDED FUNDS, BEGINNING OF YEAR | | |
| As previously reported | 1,591,635 | 1,291,296 |
| Prior period adjustment (Note 8) | (81,845) | - |
| As restated | 1,509,790 | 1,291,296 |
| TRANSFER TO CAPITAL TRUST | (222,255) | - |
| UNEXPENDED FUNDS, END OF YEAR | $1,364,652 | $1,509,790 |

## CAPITAL TRUST - Statement of Income, Expenditure and Unexpended Funds

Year Ended September 30, 1987

| | 1987 | 1986 (restated) |
|---|---|---|
| INCOME | | |
| Interest | $ 10,112 | $ 1,910 |
| EXPENDITURE | | |
| Furnishing, fixtures and equipment | 84 | 19,375 |
| Buildings | 37,378 | - |
| | 37,462 | 19,375 |
| EXCESS OF EXPENDITURE OVER INCOME | (27,350) | (17,465) |
| UNEXPENDED FUNDS, BEGINNING OF YEAR | 4,249 | 21,714 |
| TRANSFER FROM RESEARCH TRUST | 222,255 | - |
| UNEXPENDED FUNDS, END OF YEAR | $199,154 | $4,249 |

## COMBINED STATEMENT OF CHANGES IN FINANCIAL POSITION

Year Ended September 30, 1987

| | 1987 | 1986 (restated) |
|---|---|---|
| OPERATING ACTIVITIES | | |
| Working capital from operations | | |
| Increase in Research Trust | $ 77,117 | $ 218,494 |
| Changes in non-cash operating working capital | | |
| Due from University of Saskatchewan | (155,201) | (98,532) |
| Accounts receivable | (484,022) | (193,172) |
| Inventories | 1,626 | (20,992) |
| Prepaid expenses | 16,000 | 9,000 |
| Accounts payable | 21,396 | 3,362 |
| Deferred revenue | 913,334 | 211,609 |
| Decrease (increase) in non-cash operating working capital | 313,133 | (88,725) |
| Cash provided by operating activities | 390,250 | 129,769 |
| INVESTING ACTIVITIES | | |
| Additions to investments | (287,972) | (451,128) |
| Capital Trust net expenditures | (27,350) | (17,465) |
| Cash used in investing activities | (315,322) | (468,593) |
| Cash (deficiency) before investing activities) | 74,928 | (338,824) |
| FINANCING ACTIVITIES | | |
| Proceeds from loan | 150,000 | - |
| INCREASE (DECREASE) IN CASH | 224,928 | (338,824) |
| CASH, BEGINNING OF YEAR | 820,318 | 1,159,142 |
| CASH, END OF YEAR | $1,045,246 | $ 820,318 |

Cash represents funds held by the University of Saskatchewan and cash on hand.

# COMBINED BALANCE SHEET

September 30, 1987

| | 1987 | 1986 (restated) |
|---|---|---|
| **ASSETS** | | |
| CURRENT ASSETS | | |
| Cash on hand | $ 34,434 | $ - |
| Funds held by the University of Saskatchewan | 1,010,812 | 820,318 |
| Due from University of Saskatchewan - operating fund | 333,804 | 145,768 |
| Accounts receivable | | |
| Licensing agreement | 65,000 | - |
| Royalties | 16,000 | 14,236 |
| Grantors and donors | 155,500 | 49,861 |
| Contracts - research - Schedule 1 | 501,989 | 146,862 |
| - services | 17,391 | 34,727 |
| Accrued interest | 15,556 | 41,728 |
| Inventories (Note 2) | 55,476 | 57,102 |
| Prepaid expenses | - | 16,000 |
| | 2,205,962 | 1,326,602 |
| INVESTMENTS (quoted market value $798,058; 1986 - $533,760 | 824,285 | 536,313 |
| PLANT ASSETS | | |
| Site and improvements | 133,765 | 133,765 |
| Furnishings, fixtures and equipment | 431,351 | 431,267 |
| Buildings and facilities | 4,159,652 | 3,946,728 |
| | 4,724,768 | 4,511,760 |
| | $7,755,015 | $6,374,675 |
| **LIABILITIES** | | |
| CURRENT LIABILITIES | | |
| Accounts payable | $ 24,758 | $ 3,362 |
| Deferred revenue - research contracts - Schedule 1 | 1,037,799 | 81,845 |
| - sponsored research | 221,049 | 263,669 |
| Due to University of Saskatchewan - capital fund | 32,835 | - |
| Current portion of loan payable | 25,000 | - |
| | 1,341,441 | 348,876 |
| LOAN PAYABLE (Note 6) | 125,000 | - |
| | 1,466,441 | 348,876 |
| **EQUITY** | | |
| EQUITY IN CAPITAL ASSETS | 4,724,768 | 4,511,760 |
| UNEXPENDED FUNDS - RESEARCH TRUST | 1,364,652 | 1,509,790 |
| UNEXPENDED FUNDS - CAPITAL TRUST | 199,154 | 4,249 |
| | 6,288,574 | 6,025,799 |
| | $7,755,015 | $6,374,675 |

## NOTES TO THE FINANCIAL STATEMENTS

September 30, 1987

### 1. SIGNIFICANT ACCOUNTING POLICIES

These financial statements have been prepared in accordance with the following policies:

FUND ACCOUNTING

The accounts of the Organization are kept in accordance with fund accounting principles which require classification of resources into "funds" to reflect the various designated uses. Two funds are presented: the Research Trust and the Capital Trust. Funds are transferred from the Research Trust as approved by the Board of Directors and from the Capital Trust as expenditures are incurred. The balance sheet and statement of changes in financial position have been presented on a combined basis reflecting the activities of both funds.

CAPITAL ASSETS

Capital assets are recorded as Capital Trust expenditures when purchased. The same assets are included in the balance sheet as plant assets offset by the "equity in capital assets" account. No depreciation is recorded on the capital assets.

Equipment purchased with Research Trust monies is expensed as purchased, and is not included in the balance sheet as assets.

The Constitution referred to in Note 4 states that all buildings and facilities constructed for the Organization shall be used by it in accordance with the Constitution and upon termination of the Organization, the buildings, facilities and equipment therein shall remain the absolute property of the University of Saskatchewan.

INVENTORIES

Inventories are valued at the lower of cost and net realizable value.

INVESTMENTS

Investments are recorded at cost. The difference between cost and par value of the bonds is not amortized but is treated as income or expense in the year of disposal.

GRANTS AND DONATIONS

Grants and donations are recognized in these financial statements in the period defined in the terms or conditions of the respective grants or donations.

Grants and donations received without terms or conditions as to the period in which the grant or donation is to be used are recognized in the financial statements when received.

Deferred revenue consists of unexpended funds relating to specific grants and donations and is determined on the percentage of completion basis.

### 2. INVENTORIES

| | 1987 | 1986 |
|---|---|---|
| Animals | $ 8,956 | $21,555 |
| Materials and supplies | 46,520 | 35,547 |
| | $55,476 | $57,102 |

### 3. OTHER EXPENDITURES

The other expenditures consist of V.I.D.O. operating accounts including project expenses, maintenance, equipment rental, recruiting expenses, professional fees and board expenses.

### 4. ESTABLISHING AGREEMENT

The Organization was established by an agreement dated August 11, 1975 between the Devonian Foundation, the Province of Alberta, the Province of Saskatchewan and the University of Saskatchewan to conduct research on indigenous infectious diseases of food producing animals.

Effective April 1, 1980 the above agreement was replaced by a Constitution which provides for a Board of Directors to assume the responsibilities formerly performed by the Board of Advisors and the Governing Committee.

### 5. RELATED PARTY TRANSACTIONS

a) V.I.D.O. is a research affiliate of the University of Saskatchewan. The University of Saskatchewan maintains, as part of its normal operations, various financial and administrative functions relating to V.I.D.O. The financial statements do not include expenditures for administrative and ancillary services, or in-kind support provided by the University of Saskatchewan.

b) The University of Saskatchewan owns approximately 82% of a company called BIOSTAR Inc. whose primary purpose is to assist V.I.D.O. in both research and development of its products and technologies. During the year V.I.D.O. had the following transactions with BIOSTAR:

| Income from BIOSTAR Inc. to V.I.D.O. | 1987 | 1986 |
|---|---|---|
| Contract research | $231,806 | $337,329 |
| Rent, office services and management fees | 32,725 | 43,993 |
| Material purchases | 1,269 | 12,125 |
| Sponsorship of two industrial research chairs at V.I.D.O. in conjunction with NSERC | 45,483 | 46,253 |
| Expenditure by V.I.D.O. to BIOSTAR Inc. | | |
| Management service fees | 18,425 | 13,955 |
| Equipment lease | 14,766 | 25,234 |

At September 30, 1987 the Organization has a receivable from BIOSTAR Inc. of $51,269 (1986 - $133,232).

### 6. LOAN PAYABLE

V.I.D.O., in conjunction with the University of Saskatchewan, purchased land and buildings with V.I.D.O.'s share of the cost being $175,547. V.I.D.O.'s contribution was used for building improvements and equipment. The University of Saskatchewan loaned $150,000 to V.I.D.O. to pay its share of the costs. The loan is repayable to the University of Saskatchewan in six equal annual instalments of $25,000 beginning October 1, 1987 and ending October 1, 1993. The loan is interest free.

### 7. COMMITMENT

V.I.D.O. has undertaken a capital project to develop an additional 10,000 square feet of research facilities in the lower level of the building. Construction costs are estimated at $900,000 with completion scheduled for the spring of 1988. Construction costs will be financed through appropriations from the V.I.D.O. Research Trust. Appropriations will be made as the income designated for this purpose is earned.

Construction had not begun on the project as at September 30, 1987.

### 8. PRIOR PERIOD ADJUSTMENT

In 1986, due to an error in calculating the percentage of completion on two projects, which is a determinant in calculating contract revenue applicable to 1986, the excess of income over expenditure and unexpended funds were overstated by $81,845 and deferred revenue was understated by $81,845. The 1986 financial statements have been restated to correct the error and the opening unexpended funds balance for 1987 has been reduced by $81,845.

Schedule 1
University of Saskatchewan
Veterinary Infectious Disease Organization (V.I.D.O.)

## SCHEDULE OF CONTRACTED RESEARCH INCOME

Year Ended September 30, 1987

| | Accounts Receivable Sept. 30/86 | Deferred Revenue Sept. 30/86 | Funds Received | Accounts Receivable Sept. 30/87 | Deferred Revenue Sept. 30/87 | Total Income |
|---|---|---|---|---|---|---|
| Natural Sciences and Engineering Research Council of Canada (NSERC) - Co-operative Research Development Agreement | $ — | $ — | $ 800,000 | $ — | $409,220 | $390,780 |
| Agricultural Research Council of Alberta - "Farming for the Future" | — | — | 50,000 | — | 39,829 | 10,171 |
| Province of Ontario (OMAF) and Agriculture Research Institute of Ontario | — | — | — | 19,952 | — | 19,952 |
| Canada Manitoba Agri-Food Development Agreement | 10,857 | — | 52,415 | 25,874 | — | 67,432 |
| Canada Saskatchewan Sub Agreement on Agriculture (ERDA) | 37,500 | 55,634 | 75,000 | 37,500 | 54,877 | 75,757 |
| Saskatchewan Department of Agriculture | — | 26,211 | 50,000 | 50,000 | 8,707 | 117,504 |
| Agriculture Canada Livestock Productivity Improvement Program | — | — | 135,853 | 2,233 | — | 138,086 |
| | 48,357 | 81,845 | 1,163,268 | 135,559 | 512,633 | 819,682 |
| Commercial Research Contracts | 98,505 | — | 893,334 | 366,430 | 525,166 | 636,093 |
| | $146,862 | $81,845 | $2,056,602 | $501,989 | $1,037,799 | $1,455,775 |

# Publications and Presentations by VIDO Staff

## Research Publications in Scientific Journals


Babiuk, L.A., l'Italien, J., van Drunen Littel-van den Hurk, S., Zamb, T., Lawman, M.J.P., Hughes, G., and Gifford, G.A. 1987. Protection of cattle from bovine herpesvirus type-1 (BHV-1) infection by immunization with individual viral glycoproteins. Virology 159:57-66.

Babiuk, L.A., Lawman, M.J.P., and Gifford, G.A., 1987. Recombinant bovine alpha1 interferon: Use in reducing bovine herpesvirus-1 induced respiratory disease. Antimicrobial Agents Chemo. 31:752-757.

Bielefeldt-Ohmann, H., Baker, P.E., and Babiuk, L.A. 1987. Effect of dexamethasone on bovine leukocyte functions and bovine herpesvirus type-1 replication. Can. J. Vet. Res., 51:350-357.

Campos, M., and C.R. Rossi. 1987. *In vitro* induction of cytotoxic lymphocytes from infectious bovine rhinotracheitis virus hyperimmune cattle. Am. J. Vet. Res. 47:2411-2414.

Campos, M., and C.R. Rossi. 1987. Cytotoxic capabilities of bovine lymphocytes after lectin stimulation. Vet. Immunol. Immunopathol. 14:297-307.

Deregt, D., Sabara, M.I.J., and Babiuk, L.A. 1987. Structural proteins of bovine coronavirus and their intracellular processing. J. Gen. Virol. 68: 2863-2878.

Deregt, D., and Babiuk, L.A. 1987. Monoclonal antibodies to bovine coronavirus: Characteristics and topographical mapping of neutralizing epitopes of the E2 and E3 glycoproteins. Virology. 161:410-420.

Griebel, P., Schoonderwoerd, M., and Babiuk, L.A. 1987. Ontogeny of the immune response: Effect of protein-energy malnutrition in neonatal calves. Can. J. Vet Res. 51:428-435.

Ijaz, M.K., Sattar, S.A., Karim, Y.G., and Johnson-Lussenburg, C.M. 1987. Development of methods to study the survival of airborne viruses. J. Viral Methods 18:87-106.

Ijaz, M.L. Sabara, M.I.J., Frenchick, P.J., and Babiuk, L.A. 1987. Assessment of intestinal damage in rotavirus infected newborn mice by D-xylose absorption test. J. Virol. Methods 18:153-157.

Ijaz, M.K., Sabara, M.I.J., Frenchick, P.J., and Babiuk, L.A. 1987. Effect of different routes of immunization with bovine rotavirus on lactogenic antibody response in mice. Antiviral Res. 8:283-298.

Kournikakis, B., and Babiuk, L.A. 1987. Murine cytomegalovirus-pseudomonas synergistic infections: Comparison of virulent and attenuated virus. Can. J. Microbiol. 33: 923-927.

Lawman, MJ.P., Gifford, G.A., Issa, M., Dragan, R., Heise, J., and Babiuk, L.A. 1987. Immunomodulation of polymorphonuclear (PMN) leukocyte functions by recombinant bovine interferon alpha during bovine herpesvirus-1 induced respiratory disease. Antiviral Res. 8:225-238.

Mechor, G.D., Rousseaux, C.G., Radostits, O.M., and Babiuk, L.A. 1987. Protection of newborn calves against infectious bovine rhinotracheitis (IBR) by vaccination of the pregnant dam with an intranasal vaccine. Can. J. Vet. Res. 51:452-459.

Morck, D.W., Raybould, R.J.G., Acres, S.D., Babiuk, L.A., Nelligan, J., and Costerton, J.W. 1987. Electron microscopic description of glycocalyx and fimbriae on the surface of *Pasteurella haemolytica*. Can. J. Vet. Res. 51:83-88.

Nagi, A.M., and Babiuk, L.A. 1987. Bovine gut-associated lymphoid tissue: Morphologic and functional studies I; Isolation and characterization of leukocytes from the epithelium and lamina propria of bovine small intestine. J. Immunol. Methods. 105:23-37.

Potter, A.A., Cox, G., Parker, M., and L.A. Babiuk. 1987. The complete nucleotide sequence of bovine rotavirus C486 gene 4 cDNA. Nucleic Acid Research 10:4367.

Potter, A.A., Cox, G., Parker, M.D., and Babiuk, L.A. 1987. The complete nucleotide sequence of bovine rotavirus C486 gene 4. Nucleic Acids Research 14:4361.

Raybould, T.J.G., Crouch, C.F., and Acres, S.D. 1987. Monoclonal antibody passive hemagglutination and capture enzyme-linked immunosorbent assays for direct detections and quantitation F41 and K99 fimbrial antigens in enterotoxigenic *E. coli*. J. Clin. Micro. 25:278-284.

Sabara, M.I.J., Ready, K.F.M., Frenchick, P.J., and Babiuk, L.A. 1987. Biochemical evidence of the oligomeric arrangement of bovine rotavirous nucleocapsid protein and its possible significance to the immunogencity of this protein. J. Gen. Virol. 68:123-133.

Shahrabadi, M.S., Babiuk, L.A., and Lee, P.W.K. 1987. Further analysis on the role of calcium in rotavirus morphogenesis. Virology. 158:103-111.

Willson, P.J., Falk, G., and Klashinsky, S. 1987. Detection of *Actinobacillus pleuropneumoniae* infection in pigs. Can. Vet. J. 28:111-116.

van den Hurk, J.V. 1986. Quantitation of hemorrhagic enteritis vaccine antigen and antibody using enzyme-linked immunosorbent assays. Avian Dis. 30:662-671.

# Publications and Presentations by VIDO Staff

## Research Presentations, Posters and Abstracts Presented at Meetings

Acres, S.D., 1987. New approaches to vaccine production. Western College of Veterinary Medicine June Conference. University of Saskatchewan, Saskatoon, Saskatchewan. June 18.

Babiuk, L.A. 1987. Animal vaccines. 37th Annual Meeting of Canadian Society of Microbiology. Saskatoon, Saskatchewan. June.

Babiuk, L.A. 1987. Treatment and prevention of respiratory disease by interferon. Western College of Veterinary Medicine June Conference. University of Saskatchewan, Saskatoon, Saskatchewan. June 18.

Babiuk, L.A. 1987. Guidelines for working with Infectious Agents, 34th National Conference on Campus Safety. Edmonton, Alberta. July.

Babiuk, L.A. 1987. Special characteristics of bovine and human respiratory syncytial viruses. Saskatchewan Veterinary Medical Association Mid-Winter Convention. Saskatoon, Saskatchewan. June.

Bielefeldt-Ohmann, H. 1987. Bovine virus diarrhea. Western College of Veterinary Medicine June Conference. University of Saskatchewan, Saskatoon, Saskatchewan. June 18.

Bielefeldt-Ohmann, H. 1987. Immunopathology of mucosal disease. XXIII World Veterinary Congress. Montreal, Quebec. August 17.

Campos, M., Bielefeldt-Ohmann, H., Hughes, G., Babiuk, L.A., and Lawman, M.J.P. 1987. Studies on the *in vitro* biological activities of recombinant bovine tumor necrosis factor (rBoTNF). Antiviral efficacy of rBoTNF in synergy with recombinant bovine interferon gamma (rBoIFN). First International Conference on Tumor Necrosis Factor and Related Cytotoxins. Heidelberg, FDG. September 14-18.

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Deneer, H., and Potter, A.A. 1987. Iron-regulated outer membrane proteins of *Pasteurella haemolytica*. 37th Annual Meeting of Canadian Society of Microbiology. Saskatoon, Saskatchewan. June.

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Butter Fat Magazine

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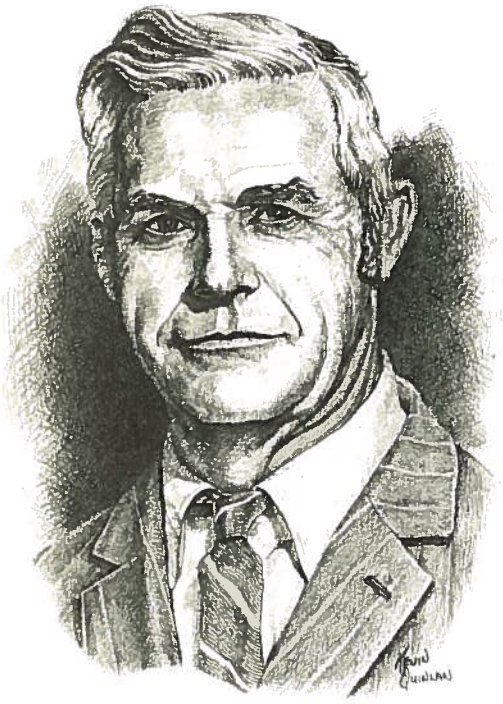

## Boyd Maynard Anderson

*Nominated for the Saskatchewan Agricultural Hall of Fame 1987 by the Rural Municipality of Waverley No. 44 and the Saskatchewan Stock Growers Association.*

Boyd Anderson, rancher and leader in farm and municipal organizations, was born on a ranch near Macworth March 1, 1920. As a boy he went to school in summer and herded sheep and fed cattle in winter. At the age of 17 he acquired his first quarter-section of land and by the age of 20 he was an established short-grass sheep rancher in the Fir Mountain area.

During the Second World War he served overseas with the First Canadian Parachute Battalion. He parachuted into France June 6, 1944. He was wounded, captured and spent 10 months in a prison camp in Germany.

In 1946 he was elected a councillor for the Rural Municipality of Waverley No. 44. He served 40 years, 27 of them as Reeve. Provincially he rose through the ranks of the Saskatchewan Association of Rural Municipalities to become President in 1977-78.

His associations with the SARM and ranching and his perception of changes that needed to be made led him to become deeply involved in related organizations. From 1969-72 he was President of the Saskatchewan Stock Growers Association and went on to become President of the Canadian Cattlemen's Association in 1976-77. He served on provincial advisory committees such as the Cattle Checkoff Fund, the Horned Cattle Trust Fund, the Wildlife Advisory Committee and the Advisory Committee on Land Use. Later he became Chairman of the Saskatchewan Beef Stabilization Board. He served for a time as delegate to both the Saskatchewan and Canadian Federations of Agriculture. He ran as a candidate twice in provincial elections and once federally.

Boyd Anderson served locally as President of the Fir Mountain Co-operative, President of the Fir Mountain Hall, on the Fir Mountain United Church Board and as President of the Glentworth Legion branch. He was an active supporter of 4-H and sports.

He received the Centennial Medal in 1967 and an honorary doctor of laws degree from the University of Saskatchewan. In 1978 he was inducted into the Northern International Livestock Hall of Fame Exposition as an honorary member and he received an honor scroll from the Saskatchewan Livestock Board in 1984.

**VIDO is honoured to have had Dr. Boyd Anderson as a Member of our Board of Directors since October 1, 1982. He is currently Chairman of the Board.**