eliminating the use of animals. Recovery of lymphocytes from animal blood is extremely expensive in terms of separation and purification costs, and the costs in terms of animal lives would be very large. Thus, the use of *in vitro* techniques to produce antibodies would lower costs and also optimize the purity of the preparations themselves.

Also called monoclonal antibodies, since the antibody-producing hybridoma is grown from one cloned cell, these cells provide a fine research tool for studying individual specificities in extremely complex immune reactions. It is now possible to categorize the human immune system by establishing hybridoma continuous cell lines for each antigen-antibody reaction. In recognition of the potential of the new cell culture techniques, equipment manufacturers are now beginning to design and offer cell culture equipment that enables mono-clonal antibodies to be bulk-produced. These systems are proving to be clean, well designed, and well able to support cell cultures in large cultivated batches.

Applications:

This technique can be used against many diseases, allergies, human reactions to many poisons, disorders of the hormonal system, neuromuscular problems such as myasthenia gravis, and many cancers. Consider the deadly small cell cancer of the lung (SCCL), often called oat cell cancer, which kills nearly all affected individuals within two years. It produces a multiplicity of hormones: calcitonin, bombesin, arginine vasopressin and ACTH. In culture, it secretes up to 18 different hormones.

In order to investigate SCCL, the scientist must selectively separate each different hormonal action. Using the cultured SCCL cell line, Frank Cuttitta and John Minna of the National Cancer Institute have created a number of separate hybridoma lines. Each cell line produces monoclonal antibodies specific for a different hormonal site on the surface of the cancerous cell. According to these scientists, these specific antibodies can be used to diagnose and type lung cancers, and may eventually provide cancer therapy by actually delivering drugs or radiation to the exact sites on the SCCL cell where hormones are produced. Cuttitta found that the technique works in culture—some of the antibodies actually block the growth of cultured SCCL cells.

There is an additional use for monoclonal antibodies in SCCL cancer, since these cells mutate spontaneously to other types of lung cancer, but

retain their surface proteins (which are "recognized" by the specific antibodies). Thus, the monoclonal antibody technique can also be used to study the different growth patterns that a cancer cell may develop, and correspondingly, to find ways to prevent this metamorphosis to cancerous types that are more resistant to conventional treatment. The implications for the replacement of animals, again, are excellent.

Monoclonal antibody techniques are part of an increasing trend towards greater specificity in cancer therapy. This specificity is the outstanding advantage, and underlies their ability to "recognize" proteins with unique structures. This eliminates the blanket approach of combatting cancer with radio- or chemotherapy, where the therapeutic agent cannot tell the difference between a "good" and a "bad" cell. The "magic bullet," the antibody, can.

Dr. Rauscher of the American Cancer Society believes that the monoclonal antibody will bring us closer to replacing the "shotgun approach of chemotherapy with a precise rifle shot," thus eliminating the nausea, hair loss, and progressive slow death from medications that are associated with conventional chemotherapy. There is also the possibility that the "magic bullet" can finish off a cancer-fighting battle begun with conventional methods, and eliminate any remaining cancerous cells that could cause a relapse.

Another feature of this technique is the tagged monoclonal antibody. Since virulent forms of cancer often spread to other parts of the body (metastasis), a means to detect new areas where the cancer may have spread would save lives, expense, and animals. The first injection of radioactive-tagged monoclonal antibodies was given to a cancer patient in 1981 at Lausanne University in Switzerland. Regions of newly metastasized cancer were detected in this patient when a radiation scan was conducted.

B. Recombinant DNA Technology

The field of recombinant DNA technology also has significant implications for the reduction or elimination of animals used in the laboratory. The concept is relatively simple:

It is common knowledge that sets of genetic instructions are embedded in cell particles called genes, and that their expression dictates many of our physical, mental and physiological traits. This includes the genetic instructions that determine the structure and functional behavior of cells, their reproduction, their nutritional requirements, their