exposure. The test substance is administered over a number of weeks, months or even years. Millions of animals of many species are used around the world every year in these procedures.

> *Rats and dogs are the most frequently used species. Of 134 studies of one month's duration or longer published in* Toxicology and Applied Pharmacology, *43.3 percent were on rats, 38.1 percent on dogs, 6.7 percent on monkeys, 3.7 percent on mice, 3.0 percent on rabbits, 1.5 percent on chickens and guinea pigs, 0.7 percent on gerbils.*[75]

However, a problem arises in attempting to use animals to duplicate exposure levels in humans over long periods of time and at low dose levels. The major technique to overcome the low-effect, time-delay problem is to greatly increase the dosage in the test animal.

One study using rats was conducted to test the effects of saccharin, a common artificial sweetener. Because the rats utilized in the study were fed such high doses of saccharin, scientists, consumer groups and industrial groups felt the study was unrealistic. For the thousands of rats sacrificed in this study, it was very real.

Another area of concern is the testing of thousands of chemicals (approximately 60,000 in common use with approximately 1,000 new substances introduced each year) in use which have not been evaluated for their toxicity. To test one of these chemicals takes two to four years and costs well over $100,000 and the lives of thousands of animals.

These costly, elaborate and cumbersome procedures are under attack. Consider the following comment made by Donald Kennedy, Director of the Food and Drug Administration under President Carter: "Compared with most other contemporary biological technology, (animal testing) is crude, cumbersome and expensive. It lacks the speed and finesse of the new techniques now being developed."[76]

Apart from the Draize test example cited earlier, there are many other possibilities for using alternatives to animals in testing and research.

Micro organisms are already being used in a variety of biomedical research activities. These single cell organisms (bacteria and protozoa) have been shown to be effective in predicting the cancer-inducing properties of toxic chemicals. The most striking example of this is the Ames test. The basis of this test is that if a chemical induces a bacterial mutation (alteration in the genetic material), it could well cause cancer. It has been shown that there is a high degree of correlation between substances which cause mutations in the Ames test and substances which cause cancer in animals. The test could, therefore, replace animals in a preliminary determination of the carcinogenic nature of drugs and chemicals.

Tissue culture is another area that shows promise for replacing animals. In tissue culture, pieces of tissue of separated cells are grown in a suitable sterile container in an appropriate nutrient medium. The use of cell and organ cultures has allowed a major British pharmaceutical company to reduce the number of mice they were using per year from 16,000 to 1600 in an antiviral agent program while at the same time increase the number of substances they were screening from 1000 to 22,000 per year.[77]

How Much is Enough?

The question also remains as to how much testing is necessary to provide safety margins in man. How beneficial should a product be before it has to go through rigorous testing which involves the lives of thousands of animals? Richard Ryder in his book, *Victims of Science*, states: "Some psychiatric patients are inveterate eaters of safety pins; does this fact mean that safety pins should be tested for toxicity on laboratory animals so that we can then know how many safety pins kill the average beagle?"