Live-Animal Use in Education

I think the biggest limitation for [veterinary] students is getting past the idea that something is an “alternative.” . . . We need to make them normal and typical, not “alternative.”

—Lara Marie Rasmussen, DVM.

5.1 Introduction

This section examines the use of living animals in education and available alternatives to such use. Specifically, the focus is on uses that will harm the animals involved. It is the position of The HSUS that living animals can and should play a vital role in education, but that their use—with few exceptions—should be limited to situations that are noninvasive and nonharmful. An important exception is for the training of veterinarians, but even here, invasive procedures can be learned in a manner that takes the animals’ interests into consideration.

5.2 The Life Sciences

Precollege Education

Invasive uses of live animals still occurs regularly in American schools, though it is less common than animal dissection in precollege education, and is prohibited in some states (e.g., California, Florida, Illinois, Maine, Massachusetts,
New Hampshire, New York, and Pennsylvania) (Leavitt and Beary 1990). Internationally, several countries have enacted laws that prohibit live-animal experimentation by students (e.g., Germany, Iceland, the Netherlands, Poland, South Africa, and the United Kingdom). A few other countries’ laws suggest implicitly that invasive live-animal use is rare or nonexistent (e.g., Argentina, Slovak Republic, and Sweden).

Just as record-keeping practices in America make it difficult to estimate accurately the amount of animal use for dissection in American schools, it is also not possible to know with any precision the frequency of invasive live-animal use. No survey has ever been done on this subject. What is known must be gleaned from curriculum outlines and materials, student complaints, journal articles, and newspaper reports.

One form of live-animal experimentation in the classroom that has occurred quite commonly in precollege classrooms is nutrition studies. As of 1987 one biology supply company advertised nine different nutritional deficiency diets available for in-class rat studies (Russell 1987). For at least two decades now, the Dairy and Nutrition Council (1987) (self-touted as “the nutrition education people”) has marketed a science kit for fourth through eighth grade school children with the intention of demonstrating the nutritional value of cow’s milk. Titled “The Great Grow Along,” the method involves providing two rats with different diets over a period of a few weeks. The effect of the diets is measured by regularly weighing and sizing the rats.

The Great Grow Along is not a good science teaching tool. First, real scientists would never use a sample size of one or two animals because it is impossible to accommodate biological variability or use statistics with so few experimental subjects. Second, the underlying premise of the study—that cow’s milk is an important part of a healthy human diet—is questionable and subject to growing dispute (Karjalainen et al. 1992; Iacono et al. 1998). Despite the claims of the dairy industry, cow’s milk is no more natural for a human child (or a rat) than is human milk for a calf. Third, the assumption—in implicit in this project—that bigger is better (in this case, in body size) is an unhealthy one to be impressing upon schoolchildren, especially in a nation beset with the highest obesity rates in the world. Fourth, the assumption that what goes for a rat goes for a human is equally tenuous; the nutritional needs of rats and humans are far from equal.

It is not known how commonly The Great Grow Along is being used in schools today. The HSUS had two complaints about it from parents in Missouri and Wisconsin in 1998. That it is used at all indicates the seductiveness of “canned” projects in a school science curriculum.

Another exercise involving live animals that is still commonly carried out in elementary classrooms is chick hatching. While less obviously harmful to animals than nutritional deprivation studies, chick hatching projects present a number of humane problems in spite of the best intentions of the teachers who conduct them. Successful incubation of chicken eggs requires meticulous care; mother hens rotate their eggs up to thirty times a day and help to maintain proper temperature, humidity, and ventilation conditions for healthy embryo development. Replicating this level of care in the classroom is difficult. The result is that some chicks die before they hatch or emerge from their eggs in a deformed or sickly state. This is disturbing to children.

Inevitably, the chicks who survive grow to be too big to keep in the classroom. It then
becomes very difficult to find appropriate places for them to go. If sent home with students, they are often unwelcome and may be treated inhumanely. Sometimes the animals are drowned or suffocated. Most often, the birds end up at animal shelters where they are usually euthanized. These problems are outlined in a NAHEE (National Association for Humane and Environmental Education) booklet of alternative activities, titled *For the Birds!*: Activities to Replace Chick Hatching in the K-6 Classroom (DeRosa 1998).

Some teachers have begun to post on the Internet classroom exercises that involve invasive uses of live animals. Access Excellence Program, www.gene.com/ae/MTC>, a place for science teachers to share their ideas, is one such place where these postings may be found, though it should be noted that these sorts of postings tend to be ephemeral, and none of the following examples could be found six months after they were originally discovered in the fall of 1998. A Delaware-based high school teacher included a study exposing fish to tobacco among a series of projects she conducts with her science class. Though she was careful to note that the fish do not succumb to their exposure, it is apparent that the exercise is not in the fish’s best interests. Similarly, a Wisconsin-based high school teacher has her students study the effects of temperature variation on respiration rates in goldfish. Two other examples involve dissection of living insects. One describes an exercise in which flour beetles (*Tenebrio molitor*) are “inactivated” by spending ten minutes in a freezer before being wax mounted, submerged in Yæger’s saline, then dissected by students. Another describes the dissection of a live cricket (St. Remain 1991). In light of uncertainty regarding pain perception in insects, the previous exercises may not be problematic in humane terms, but the same may not be true of the effects on children’s sensibilities when they are instructed to harm and kill living creatures (see chapter 3).

**Postsecondary Education**

At the college level, invasive and/or harmful uses of live animals are relatively more common, most notably in the fields of physiology, psychology, pharmacology, and zoology. Two traditional physiology labs that remain fairly common in American colleges are the frog gastrocnemius muscle and the turtle heart preparations.

In the frog muscle physiology lab, live frogs (usually leopard frogs, *Rana pippiens*) are rendered brain-dead by pithing. Frog pithing is still occasionally done by inserting one blade of a pair of scissors into and across the mouth of a (live and fully conscious) frog and slicing the top of the head off. Sometimes the animal is “double-pithed” by destroying the spinal cord as well with a thrust of the probe through the vertebrae. Following pithing, the gastrocnemius muscle of the frog is dissected out of the body and hooked up to an electrical recording device so that various aspects of muscle response to electrical stimulation can be observed and recorded. A Web site that shows the steps involved in isolating a frog nerve can be found at <umech.mit.edu/freeman/6.021J/schindjr/lab/frog-lab-home.html>.

In the turtle heart lab, a turtle (usually a freshwater species, such as the red-eared turtle, *Chrysemys scripta elegans*) is pithed, then the plastron (undershell) is removed with a circular saw so that the living heart can be observed. Various chemical compounds are applied directly to the heart to observe stimulating and retarding effects on the heartbeat; the vagus nerve in the animal’s neck may also
be manipulated to observe the effects on heart function.

It is difficult to know the prevalence of pithing exercises in American schools today. It is safe to say that the practice is quite rare in high schools and is more usually done in undergraduate physiology courses. Robinson (1996) reports that Carolina Biological Supply Company ships out between 75,000 and 90,000 live frogs per year. Some of these animals probably go to scientific research projects and some to pithing labs. While the pithing procedure itself is usually done out of view of the students, this is not always the case. Many students who witness pithing have strong aversive reactions to it (see section 3.4). The HSUS is aware of at least two recent student campaigns (at the University of Georgia and Cornell University) to end pithing labs.

In addition to pithing labs, many other invasive uses of live animals occur in advanced undergraduate courses. According to 1996 figures (the most recent available) released by the Canadian Council on Animal Care (CCAC 1999), 300 animal experiments reported under the heading of “Education and Training of Individuals in Postsecondary Institutions and Facilities” were classified as in the category E of severest pain. Data of this sort are not available in the United States, but comparable animal use practices occur, especially in advanced life science courses.

Such a course is taught in Ohio State University’s (OSU) microbiology department. The HSUS obtained information on this course in 1995 from the Institutional Animal Care and Use Committee (IACUC) minutes sent to The HSUS by an Ohio-based animal rights group (Protect Our Earth’s Treasures), which had recently won a lawsuit granting them access to OSU’s IACUC minutes.

The course, titled “Principles of Infection and Host Resistance,” accommodates up to 125 students per year. The instructor’s 1995 request for IACUC approval described five invasive animal labs, involving 475 mice and 20 rabbits:

- 20 rabbits given Freund’s complete adjuvant and bled via intracardiac puncture
- 20 mice killed by cervical dislocation (neck breaking), then dissected to obtain bacterial slides and swabs from abdominal organs
- the lethal bacterium (*Streptococcus pneumoniae*) injected into the stomach cavities of half of a group of 135 mice (the remainder were injected with a saline solution as a control); mice observed every forty-eight hours for ill effects
- 250 mice each receive four injections into the stomach cavity over a four-week period; all are exposed to the infectious bacterium *Salmonella typhimurium*; all mice are killed in this lab
- 65 mice are injected twice with the infectious bacterium *Staphylococcus aureus*

The occurrence of invasive live-animal procedures bears more relation to the preferences of the instructor than to the learning requirements of the discipline itself. In all of the life science disciplines, one finds many examples of programs where animals are not used. The most salient example is the use of animals in medical training, where about half of the 126 U.S. medical schools do not use animals (section 5.4).
5.3 Alternatives to Live-Animal Use

Most live-animal experiments in education can be replaced by nonanimal alternatives (Nab 1989). Because these experiments have been conducted repeatedly, year after year, the parameters and results are known, and the experiments can thus be simulated by other learning methods. This approach does not compromise the scientific rigor of the lesson, because it is the learning process that counts, not the experimental results themselves (ibid.).

Nab (1989) lists advantages of computer simulations over invasive live-animal labs:

- students must be active or else nothing happens
- students can study many factors at one time and vary parameters on a large or small scale
- the simulated “animal” can be repaired; students can make “fatal” mistakes without losing the experiment
- the computer can give feedback, provide hints, and offer help
- slow processes can be accelerated and fast ones slowed down
- experiments can be repeated at any time and almost any place
- the simulation can be simplified to negate confusing side effects, which can hinder the understanding of basic principles
- fewer animals are used

These advantages are borne out by the results of published studies that find student learning performance when using computer-based (and other) alternatives to be at least equal to that of students using live animals (see table 4.1).

In addition to the advantages of computer simulations, Nab (1989) also mentions a few limitations. These include:

- a mathematical model is never complete and cannot exactly simulate the complexity of a living biological system
- simulations do not provide student contact with living animals
- computer simulations cannot train manual skills, like surgery and handling

As Nab observes, the first limitation above is not important for most educational uses, which usually involve the study of basic principles that most computer simulations are designed to mimic. That simulations deprive students of contact with animals is not a criticism of simulations; an instructor who values student contact with real animals will ensure that students get it whether or not he/she makes use of computers.

Physiology is traditionally one of the heaviest users of invasive procedures in animals. A survey by the Association of Chairmen of Departments of Physiology (Greenwald 1985) reported that most physiology faculty believed that no alternative could fully replace live-animal use in education. Respondents also reported that alternatives limited students’ exposure to working with live subjects as well as student experience with interaction in the complex systems of a living thing.

These points are self-evident, and they do not say anything about the efficacy of alternatives. One could as soon criticize live-animal use on grounds that it takes away time that could be spent using the alternatives, which have features unavailable to the student who studies only animal subjects (see above).

At the instructional level, the use of animals is based more on personal preference than on pedagogical necessity, as there are many examples of animals being replaced...
altogether in physiology curricula. Kerstin Lindahl-Kiessling of Sweden’s Uppsala University, for example, designed the physiology course for biological science students without any animal experiments. She believes that animals are not needed for good physiology teaching because there are so many other ways to demonstrate physiological principles (Alternatives in Education 1999). Sewell et al. (1995) provide an example of the effective use of a multimedia computer package to replace the frog heart and sciatic nerve–gastrocnemius muscle preparations.

Many other instructors have praised computer-based physiology labs, noting such benefits as teaching students to manipulate ideas like scientists do (Tauck 1992), allowing students to conduct real experiments (Stringfield 1994), motivating students (ibid.; Kuhn 1990), and teaching respect for life (Tauck 1992). Clarke (1987) described the advantages of using simulations over traditional nerve isolation experiments, noting that by avoiding the tedious, often unsuccessful isolation and preparation of the nerve tissue, the simulation allowed much more time to be devoted to the experiment itself, so that students could explore the subject in greater depth. Other studies demonstrating time savings when using alternatives to traditional animal physiology labs include Fawver et al. (1990), Dewhurst et al. (1994), and Brown et al. (1998).

Other notable resources that have successfully replaced traditional live-animal physiology exercises include:

The Virtual Physiology Series (five CD-ROMs), produced at the University of Marburg, Germany, covers the entire field of nerve-muscle physiology and simulates all of the classic experiments conducted by medical, dental, veterinary, biology, and chemistry students; these programs are in use in both Europe and North America, and faculty response has been enthusiastic (Thieme Interactive n.d.).

The SimBioSys Physiology Labs use animations, simulations, exercises, and quizzes, and cover general, cardiovascular, respiratory, and renal physiology; over 1,000 physiological parameters can be reproduced; by altering parameters, students gain understanding of how the body works (Critical Concepts, Inc. 1999).

DynaPulse Systems allows students to monitor their own cardiovascular profiles; also includes a “patient management” system that allows long-term tracking and statistical analyses of students’ cardiovascular status (Pankiewicz 1995).

InteliTool’s software series allows students to study respiratory physiology (Spirocump), muscle contraction (Physiogrip, Flexicomp), and cardiac physiology (Cardiocomp); students generate their own original data from their own bodies, making them both the investigators and the experimental subjects (InteliTool 1998).

Pharmacology is another high user of live animals in education. Loiacono (1998) describes the use of alternatives to replace traditional pharmacology labs at the University of Melbourne (Australia). Traditionally, various drugs were screened for their behavioral effects on animals and the students were expected
to produce a profile of these effects for various families of drugs. The alternative, a CD-ROM package titled *Behavioural Pharmacology*, allows the student to review a larger range of drug families, including those such as convulsants and central stimulants that the instructors regarded as ethically untenable for an undergraduate practical class. Other advantages include short video-sequence reviews of the types and uses of behavioral tests, a series of self-assessment tests, additional text-based material, and a presentation format that combines figures of drug structures alongside behavioral effects and allows the student to quickly link to any other part of the program. The instructors report being able to broaden the scope of the class and to incorporate elements that would be too time-consuming in the traditional laboratory setting. This alternative also represents a reduction in animal use. Concomitant disadvantages are that students see only “ideal” responses that do not depict the interindividual variability in drug response, and the students are less involved in the decision-making that accompanies live-animal experimentation. Loiacono (1998) reports that these factors are being overcome with approaches that are more interactive, allowing the student to participate actively in the presented experiment.

At the University of Queensland, Lluka, and Oelrichs (1999) describe 89 percent reduction in animal use between 1980 and 1999 in physiology and pharmacology programs. Among their teaching strategies are recorded experiments, broadcast experiments, simulated experiments, interactive tutorials, and human experiments (with student volunteers). The authors emphasize the importance of knowledgeable instructors, good design of accompanying notes, and the need to “ensure that the students relate to the exercise as a practical experiment and not as a computer exercise” (6).

For the acquisition of practical skills, there are many noncomputer, nonanimal alternatives available (see the following section). When Nab (1989) wrote his article, computer simulations were not yet available to mimic the manual and tactile experience of surgical exercises. However, today, the technology of virtual reality (VR), while not yet widely available, can provide a realistic training experience for many of the practical skills that medical professionals use (Coppa and Nachbar 1997). The VR project at the New York University School of Medicine is now used extensively by faculty and students and plays a vital role in the school’s medical curriculum (ibid.).

Ultimately, practical laboratories seek to expose students to the process of doing science and to the types of difficulties and uncertainties that might be encountered. Hands-on experience is also important and any study of biology should definitely include exposure to living animals (including students!). The HSUS argues that a true “respect–for–life” ethic requires that harmful animal use in schools should be eliminated.

**5.4 The Health Sciences**

**Medical School**

In the past, the use of live animals has been routine practice in the American medical training curriculum (Foreman 1992). However, recent trends indicate that animal use is declining. According to the Physicians Committee for Responsible Medicine (PCRM), which for the past decade has been pressuring medical
schools to replace animal labs with nonanimal alternatives, about half of all 126 U.S. medical schools—including such prestigious institutions as Mayo, Harvard, Columbia, and Yale—now have no live-animal laboratories (PCRM 1998). One clear conclusion that can be drawn from this information is that live-animal use is not indispensable for medical training.

The most common live-animal lab conducted in U.S. medical schools is the “dog lab,” in which students perform a series of terminal procedures on anesthetized dogs. Besides dogs, other animals commonly used by medical schools are pigs, cats, and rabbits. Most often, the animal labs occur in the disciplines of physiology, pharmacology, and surgery (Wolfe et al. 1996).

Animals are also used in more advanced medical training. Examples include use of dogs and pigs for Advanced Training and Life Support, use of cats and kittens for intubation training, and use of pigs and dogs for laparoscopy and surgical stapling. Ohio State University’s medical school, for example, has been using 120 adult dogs and 120 adult pigs yearly for laparoscopy and surgical stapling of the intestine and stomach (OSU IACUC minutes, March 1995), and as of 1999 (Richard Tallman, personal communication) continued to do so. That any medical institution trains its students without the use of live animals clearly indicates that live-animal labs are not an indispensable part of medical training (OTA 1986).

Alternatives for Medical School
A survey by Barnard et al. (1988) found that live-animal labs existed in the regular curricula of 49 of 93 responding physiology departments (53 percent), 27 of 110 responding pharmacology departments (25 percent), and 15 of 81 responding surgery departments (19 percent). A 1994 survey by Ammons (1995), to which 125 of the total 126 U.S. medical schools responded, showed further declines in live-animal use for all three subdisciplines, to 39 percent, 10 percent, and 17 percent, respectively. Results from a survey by Wolfe et al. (1996), also conducted in 1994, yielded higher percentages for each subdiscipline (41 percent, 16 percent, and 30 percent, respectively); however, response rate was considerably lower for this study, with only 66 percent, 59 percent, and 63 percent of the total number of each subdiscipline departments returning surveys, so Ammons’s results should be considered more representative. Table 5.1 summarizes these findings.
Table 5.1
Percentage of U.S. Medical Schools with Live-Animal Laboratory Exercises in Various Departments

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<tr>
<td>Physiology</td>
<td>62.5</td>
<td>(n = 16)</td>
<td>53 (n = 93)</td>
<td>40 (n = 125)</td>
<td>41 (n = 83)</td>
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<tr>
<td>Pharmacology</td>
<td>50</td>
<td>(n = 16)</td>
<td>25 (n = 110)</td>
<td>10 (n = 125)</td>
<td>16 (n = 74)</td>
</tr>
<tr>
<td>Surgery</td>
<td>62.5</td>
<td>(n = 16)</td>
<td>19 (n = 81)</td>
<td>17 (n = 125)</td>
<td>30 (n = 80)</td>
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\(^a\) Office of Technology Assessment

It is not necessary that surgeons must first train on animals before graduating to humans. Of those medical schools still using animals, all but one (the military’s Uniformed Services University of the Health Sciences, in Maryland) present the terminal dog lab as an optional exercise. Still, the dog lab is used by about half of the 126 medical schools in the United States (Physicians Committee for Responsible Medicine 1997) and, where the lab is in place, students report that they are under considerable pressure to take it. Arluke and Hafferty (1996) concluded from their study of students at a Midwest American medical school that “the medical school culture provided absolutions to students that neutralized their moral apprehension about dog lab.”

Though studies are few, the dog lab would not appear to have any pedagogical advantage over alternatives developed to replace it. In a study involving 110 medical students, both computer demonstrations and animal (dog) demonstrations were used and the former was rated higher by the students for learning cardiovascular physiology (Samsel et al. 1994). A study by Carpenter et al. (1991) documented equivalent training outcomes in medical students using cadaverized dogs compared with students using living, anaesthetized dogs, though both of these approaches are ethically charged.

Having students watch doctors performing operations in place of dog labs is becoming more common in American medical schools. Dr. Michael D’Ambra, who heads the Harvard Medical School’s operating room program, believes that “the only thing a student can do in a dog lab that we don’t cover in the operating room is killing the animal after the observation process is over” (McNaught 1998).

Regulations for the use of animals in medical training are stricter in Great Britain, where the apprenticeship approach to surgical training has been used for decades (Stephens 1986; Morton 1987). Under the Animals (Scientific Procedures) Act of 1986, use of animals for microsurgery training is now permitted, but only if the following conditions are met: the express consent of the Secretary of State must be obtained, the licensee must show that he/she is likely to be using microsurgery in his/her professional work, and only rats under full terminal anaesthesia may be used (Morton 1987). Furthermore, use of decerebrate animals for training, which was outside the scope of the 1876 law, is prohibited by the 1986 law (ibid).

There is no question that hands-on surgical training improves surgical skills. The chal-
The challenge for the future is how to provide the practical training without harming either human patients or animals. Perhaps computer-generated virtual reality will provide that answer.

Clinical Case-based Learning

The most important alternative to animal labs in medical training is the clinical apprenticeship teaching paradigm. The student trains in the true patient setting, being gradually given more responsibility and involvement as student competency improves. This case-based approach is the standard in Great Britain. The traditions of internship and residency in the United States are also examples of the apprenticeship training paradigm. This portion of medical training places the student in the real-life situations he/she will encounter as a professional practitioner.

Existing data show that case-based learning is favored by medical students. Lavine (1993) surveyed medical students at George Washington University, who in turn rated clinical case-based learning higher than laboratory sessions, basic lectures, and textbooks. By contrast, traditional terminal dog labs engender considerable worry and soul-searching for many medical students. Arluke and Hafferty (1996) found that medical students learn to use moral “absolutions,” or reassurances, to cope with these feelings about dog labs.

Another valuable use of humans in medical training is the use of newly deceased patients to teach resuscitation procedures (Burns et al. 1994). A 1992 survey by Burns et al. (1994) found that 63 percent of U.S. emergency medicine programs and 58 percent of neonatal critical care programs allowed procedures to be performed on patients after their death. Tracheal intubation was by far the most commonly practiced procedure, but at least seven other procedures were also practiced. Postautopsy and prosected cadavers are a valuable resource for teaching surgical psychomotor skills and human anatomy (Jones et al. 1978; Morton 1987; Peterson 1993).

One of the drawbacks of clinical case-based experiences is that mistakes are costly and could endanger human life. This is where clinical simulations are invaluable. To supplement clinical-based training, simulations of case-based medicine are gaining ground as computer technology continues to improve. The University of Florida’s $60 million brain institute includes a computer-driven patient simulator. Students use the simulator in emergency room drills, among other uses.

Other Alternatives

Beyond the clinical realm, the quality of replacement alternatives for medical training is already high and their availability is growing fast. Alternatives include human patient simulators (Stephanovsky 1998) and computerized mannequins (McCaffrey 1995), surgical and microsurgical training boards (Van Dongen et al. 1996), perfusion models, laparoscopy simulators (Tsang et al. 1994), and a wide range of computer platforms for learning anatomy, physiology (cardiovascular, pulmonary, renal, etc.), and gastrointestinal and muscle function (Carlson 1995). Virtual reality (VR), a developing technology with enormous future potential in the medical profession, is already making inroads into medical training (Coppa and Nachbar 1997; Thanki 1998). Alternatives have also been developed for advanced training in medical specialties, such as eye surgery (Hale 1989; Sinclair et al. 1995), and advanced trauma life support (ATLS).
Stephanovsky (1998) describes the success with which a new learning tool called the Human Patient Simulator (HPS) is being incorporated into the training of nurses, emergency medical services personnel, military personnel, and others. The HPS uses the principle of some of its veterinary predecessors (e.g., Resusci-Dog™, Resusci-Cat™) to create a lifelike mannequin that presents various vital signs and allows for a variety of manipulations. Among the features of this model are breathing and heart beat (normal and abnormal); palpable radial and carotid pulses; anatomy suitable for intubations and inductions; central venous, arterial and pulmonary arterial pressures; pulmonary capillary wedge pressures; oxygen saturation; and urinary catheterization (both male and female). HPS also allows students to administer over sixty different medications through three intravenous access sites (femoral, radial, and central) to which the “patient” then reacts according to patient profile, diagnosis, and amount delivered. Different monitors can be installed into the mannequin to provide diverse training experiences. One of the more simple yet innovative features of HPS is the speaker implanted into the throat area, allowing the instructor or another student, wearing a wireless microphone, to make it sound as if the patient is speaking; this provides valuable experience with the acquisition of patient assessment and bedside manner skills. These features allow students to track the patient as a complete case history from start to finish (Stephanovsky 1998).

Another example of innovation is the POP-Trainer (POP = perfused organ preparation), a simple but highly realistic apparatus for simulating operations. Waste slaughterhouse organs are perfused with a blood substitute in a closed system and operations are performed while the POP-Trainer pumps the fluid through the vessels in a lifelike manner. Other equipment from ultrasound to laser can be added. This device won the 1993 Felix Wankel Animal Protection Research Prize. Provided slaughterhouse materials are relinquished free of charge, The HSUS does not disapprove of making use of their availability for advanced training of this sort.

For the development of surgical skill, Reid and Vestrup (1986) credit models and simulations as being the best way to develop surgical skill and improve confidence prior to patient contact. Dennis (1999) surveys some of the inanimate surgery training models being used in veterinary and medical training programs. His conclusion is that currently, optimum training combines the use of both inanimate trainers and living animals, and that inanimate training aids, by themselves, can be as good as, or superior to, live-animal training methods.

Sophisticated and expensive equipment is not a prerequisite of effective surgical skills training. At the University of Pittsburgh, lacerated foliage leaves have been used for the introduction and refinement of microvascular suturing skills. Because the fragility of plant tissue (as compared with human tissue) exaggerates any damage done due to errors in technique, the use of plant tissue may enhance the trainees’ acquisition of skills (Kaufman et al. 1984). At Erasmus University Medical School, in the Netherlands, frogs and rats were replaced with bicycle inner tubes and fig leaves in surgical training (Will Kort, personal communication, 1994). For microsurgery training, a range of options exists, including human placentas (McGregor 1980; Townsend 1985), inexpensive training cards (Awwad 1984), and a rat model for developing microsurgical skill, which was recently developed in the
Netherlands (van Dongen et al. 1996). Newsome et al. (1993) describe the replacement of live animals with tissues isolated from human and animal cadavers for use in laser surgery training and the reduction in animal use and in costs that accrued.

Exposure to real surgery in the operating room theater is obviously a vital component of surgical training (Morton 1987). As well as discarding its terminal dog surgery labs, Harvard University has begun sending its students to Massachusetts General, Beth Israel, and Brigham and Women’s Hospitals, where they observe and study surgical procedures in the operating room (McNaught 1998). Observing operating room procedures helps medical students understand what it takes to apply medicine to real-world situations that help save and improve human lives.

Computer-based learning materials allow medical students, like their counterparts in other science fields, to work at their own pace and control various parameters in the experiment so that different effects can be observed. The computer-based experiment can also be repeated, an option rarely available in the animal experiment. Combining these resources is a way to further the benefits of each. Stanford et al. (1994) found that computer simulations used in conjunction with a dissection (of the human heart) enhanced learning compared with either computer training alone or the dissection alone.

Veterinary School
Veterinarians take an oath that includes the alleviation of animal suffering. Yet the invasive use of healthy animals in no need of medical intervention is widespread in U.S. veterinary schools. A census of all 27 U.S. veterinary schools conducted by the Office of Technology Assessment (OTA) in 1983-1984 estimated that 16,655 animals were being used yearly at that time, the most commonly used species being dogs (>8,000), mice (>2,000), rats (>2,000), and birds (>1,300). Uses include training in surgical techniques and dissection of animal cadavers. In most of these cases, the animals are dead or anesthetized at the time of use.

Veterinary schools in the United States are following the trend away from consumptive uses of healthy animals in their training programs. Anecdotal evidence indicates that animal use has declined since the OTA study in 1983-1984. Most of the veterinary schools in both the United States and Canada now have alternative tracks available for students who wish to minimize such contact with animals in their training. Many students report feeling pressure to do the traditional labs for fear that they may otherwise be less competent and/or may not be hired into the professional ranks. However, White et al. (1992) found that of three graduating veterinary students who had taken the alternative track in the Washington State University veterinary program, all received job offers, and two of them were hired because of (not in spite of) their participation in the alternatives program.

Harmful uses of animals has, for several years now, been eliminated in all six British veterinary colleges (Knight 1999).

The allied field of veterinary technology, whose graduates typically work as assistants in veterinary hospitals, also uses many animals to practice invasive, potentially painful procedures. A list of “essential” procedures for accreditation by the American Veterinary Medical Association (1998) for training technicians includes tail docking, and the dehorning of cattle and goats. A veterinary technology stu-
dent at the University of Cincinnati complained to The HSUS in 1997 that stu-
dents with little or no prior training were required to perform oral dosing of rats
(in which four of the animals died); intraperitoneal and intramuscular injections
of mice, rats and rabbits; and jugular blood drawing from dogs. Veterinary tech-
nicians on the job must often perform many blood drawings daily. But a more sen-
sible and humane approach would involve students working with lifelike prosthet-
ic models (see next paragraph), then working with live animals under close
supervision in the clinical setting, rather than using purpose-bred rodents.

Alternatives for Veterinary Training
Nonanimal surgical training devices are used extensively in veterinary schools to
help students hone skills prior to their application to live-animal tissue. Anatom-
ical models, for example, have proven effective in the training of veterinary skills
and techniques (Johnson and Farmer 1989; Greenfield et al. 1993, 1995; Holm-
berg et al. 1993; Holmberg and Cockshutt 1994). Soft-tissue plastic models of
canine abdominal organs developed at the University of Illinois were found to have
comparable handling properties and were useful for teaching a range of common
surgical procedures (Greenfield et al. 1993). The Scottish-based company More-
dun (n.d.) produces simulators for practicing a variety of common procedures
done by veterinarians or their assistants, including a mouse tail that forms a
hematoma if poorly handled during “blood” drawing.

The DASIE (Dog Abdominal Surrogate for Instructional Exercises), developed at
the Ontario Veterinary College, has also been successfully used to prepare stu-
dents for live surgery (Holmberg et al. 1993; Holmberg and Cockshutt 1994).
More rigid plastics have been used to make bone models, and these have been
used effectively for demonstrating and teaching many aspects of bone-related
surgical procedures (DeYoung and Richardson 1987; Johnson et al. 1990). Of
twenty-seven respondents to a survey of all thirty-one veterinary schools in the
United States and Canada, Bauer (1993) reported that plastic bones were being
used in eight schools (30 percent) to teach fracture repair. A model of a dog
stomach developed and tested at Ohio State University by Smeak et al. (1994)
had mixed results; it was effective for teaching some procedures but was not found
to enhance the confidence of students faced with live-animal surgery, suggesting
that accompanying instruction was necessary. Table 5.2 presents studies of
alternative methods and approaches in veterinary education.
Table 5.2
Studies Evaluating Alternatives in Veterinary Medical Education

<table>
<thead>
<tr>
<th>Authors</th>
<th>Study Subjects</th>
<th>Principal Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpenter et al.</td>
<td>24 third-year veterinary students</td>
<td>No significant differences were detected between the surgical performance of two groups, one trained using live animals, the other using cadavers (source unknown).</td>
</tr>
<tr>
<td>Erickson and Clegg 1993</td>
<td>82 U.S. veterinary students</td>
<td>Of 14 learning methods for basic cardiac teaching and ECG interpretation, computer-based active learning was rated the highest in student evaluations.</td>
</tr>
<tr>
<td>Fawver et al. 1990</td>
<td>85 first-year U.S. veterinary students</td>
<td>Use of interactive videodisc simulations yielded equivalent test performance and greater time efficiency in teaching cardiovascular physiology compared with instruction in a live-animal laboratory.</td>
</tr>
<tr>
<td>Greenfield et al. 1995</td>
<td>36 third-year U.S. veterinary students</td>
<td>Surgical skills were evaluated following training with dogs and cats, or soft-tissue organ models; performance of each group was equivalent.</td>
</tr>
<tr>
<td>Johnson and Farmer 1989</td>
<td>100 U.S. veterinary students</td>
<td>Inanimate models effectively taught basic psychomotor skills and had the advantage over live animals that they could be used repeatedly, enhancing the acquisition of motor proficiency.</td>
</tr>
<tr>
<td>Pavletic et al. 1994</td>
<td>48 U.S. veterinary graduates</td>
<td>No difference was found in surgical confidence or ability of graduates who had participated in an alternatives course of study versus those who had participated in a conventional course of study.</td>
</tr>
<tr>
<td>Sandquist 1991</td>
<td>373 U.S. veterinary students</td>
<td>51 percent of students felt that alternatives to surgery labs should be available to students unwilling to participate in terminal surgeries.</td>
</tr>
<tr>
<td>White et al. 1992</td>
<td>7 fourth-year alternative track veterinary students</td>
<td>After hesitancy in their first live-tissue surgery, students from an alternative surgical laboratory program performed on par with students with a standard laboratory experience.</td>
</tr>
</tbody>
</table>

The technology of VR also has applications to veterinary education. The School of Veterinary Medicine at Michigan State University, for example, is currently establishing a curriculum that relies heavily on VR. Endotracheal intubation, ovariohysterectomy and castration, intravenous catheterization, and venipuncture are some of the procedures being transformed into VR technology (Thanki 1998). A unique advantage of VR over traditional surgical training methods is that virtual images can be enlarged, even to the point of allowing the student to “walk” around inside the abdominal cavity of a dog.

Suturing is a vital but basic skill that can be easily simulated without having to use live or dead animals. Not surprisingly, even relatively simple synthetic suture simulators have been shown to improve veterinary surgical skills over merely observing suture technique (Smeak et al. 1991). Bauer and Seim (1992) describe two inanimate models—the fluid homeostasis model and the interactive electronic suturing
board—developed at Colorado State University that can be used for both teaching and objective evaluation. Among the many advantages of these nonanimal surgery training devices are that they are inexpensive, they allow repeated use at the student’s convenience without the need for aseptic surroundings, and they are not ethically problematic. They help improve proficiency so that subsequent experiences with surgery on animals will be more rewarding and more likely to bolster confidence.

**Learning in the Clinical Setting**

Increasingly, veterinary schools are using animals in the clinical setting to help train their students. A fast-growing practice is the spay/neuter of cats and dogs from local shelters. Bauer (1993) reported that 16 of 27 North American veterinary schools (59 percent) had implemented some type of program with local humane societies. Among the schools now using this approach are Ohio State University (Smeech 1998), Tufts University (Patronek 1998), Kansas State University (Roush 1998), Mississippi State University (Bushby 1997), and Colorado State University (Jones and Borchert 1999). This is a win-win-win situation for the school (which gains access to a low-cost source of animals for surgical training), the shelter (which receives virtually free spay/neuter services), and the animals (who are more likely to be adopted afterward). One of the distinct advantages of this approach, as compared with performing terminal surgeries on animals, is that it gives students exposure to all phases of patient care, including postsurgical pain management. As Brown et al. (1993) report, programs for teaching that involve surgery on animals should include perioperative experiences; that is, they should involve all aspects of preoperative, operative, and postoperative experience.

Tufts University’s anatomy and medical skills programs recently achieved the goal of using only cadavers donated by clinic clients whose companion animals had died a natural death or were euthanized for medical reasons (Patronek 1998). The main surgery courses now use shelter animals who are later returned to the shelter for adoption. Tufts also offers field experience in surgery and shelter medicine through externships to animal shelters, a Native American reservation in Nevada, and a one- to two-week summer feral cat sterilization project in one of the Virgin Islands (ibid.). Veterinary students also can and should gain valuable surgical training in the operating room under the close supervision of an experienced surgical instructor/practitioner (Johnson et al. 1990). Here, the student mostly observes at first, performing relatively simple procedures like incision making and suturing; as competence and exposure develop, the student takes on more complex surgical tasks.

Bauer et al. (1992a, b) describe curricular changes made at Purdue University’s veterinary school, which replaced use of two consecutive survival surgeries performed on purpose-bred cats and dogs with a greater emphasis on clinical casework and use of animals from local animal shelters (both cadavers and live animals for spay/neuter surgery). The authors found that students’ motivation, attitude, and self-confidence remained undiminished following these changes (Bauer et al. 1992b), and that the new approach also yielded budgetary and social benefits (Bauer et al. 1992a). The use of animal cadavers has also been found to be as instructive as the terminal use of living dogs for training veterinary students in surgery techniques (Carpenter et al. 1991; Pavletic et al. 1994). White et al. (1992) found that students who had studied
surgery using cadavers were more timid and hesitant during their first surgery on a live animal, but thereafter, these students performed on par with other students on this and all other segments of the surgery and anesthesia rotations. Ten veterinary students at Kansas State University showed superior surgical skills after repeatedly conducting survival surgeries on animals who were returned to a local shelter for adoption (the “new” curriculum) than did students who performed a number of terminal surgeries (the “old” curriculum) (Fingland 1999).

Nedim Buyukmihci, a veterinarian with the School of Veterinary Medicine at the University of California–Davis, has proposed the use of terminally ill companion animals for surgical training. The animal’s guardian would sign a consent form, the patient would be deeply anesthetized, then the various training procedures would be done before the animal was killed via overdose without recovering consciousness (Buyukmihci 1995).

It is important to note that the surgical training that students receive at veterinary school does not make them proficient surgeons. Logistics, costs, and time constraints require that the amount of hands-on surgical experience is limited. It is not until veterinarians apply the lessons learned through repeated practice on the job that they begin to attain high levels of surgical competence and skill.

For students seeking instruction in laboratory animal handling techniques, Duffy (1999) summarizes examples of positive applications of various alternative methods. These include simulation models (for restraint and handling, venipuncture, endotracheal intubation, and surgical technique) and computer media, including virtual reality CD-ROMs now available from the School of Veterinary Medicine at the University of California–Davis. Innovative models of both the rat and the rabbit have been developed by the Japanese company Koken. The Koken Rat, a realistic model of a nineteen-week-old male laboratory rat, allows lab technicians, veterinary students, and others to learn proper methods of handling, dosing, injecting, intubating, and drawing blood. These models are now in use in many institutions around the world (EuroNICHE 1999). Resusci-Dog and Resusci-Cat are also widely used for training veterinary technologists and other allied professionals in emergency treatment and life support for companion animals. Rescue Critters, a new line of animal mannequins for the training of veterinary and veterinary support staff, are now in use at twenty-three U.S. colleges as well as five overseas schools, and over 200 chapters of the American Red Cross’s Pet First Aid classes (Craig Jones, personal communication, 25 October 1999).

Training in animal welfare issues is also improving, with at least seven U.S. veterinary schools now offering such courses (Self et al. 1994; Balcombe 1999). British veterinary schools (with one exception) provide a required course devoted to animal welfare (Stewart 1989), wherein students are taught all the factors that contribute to animal health and well-being and learn to identify signs of pain and distress and suffering in different species of animals (ibid.).

For certain skills, live-animal use is beneficial, even indispensable, to the training of veterinarians. It does not follow, however, that healthy animals need be harmed to obtain such skills. Just as students in the field of human medicine can be trained to be excellent, life-saving practitioners without ever killing or deliberately harming another human being, veterinary students ought to be able to do the same without harming or killing animals.
5.5 Science Fairs

Because they fall somewhat outside the purview of sanctioned classroom animal use, and because they may involve more ambitious scientific explorations than typically occur in the classroom, science fairs have more potential to include invasive use of live animals than any other facet of precollege education. The history of science fairs over the past several decades contains many examples of students being awarded prizes for science fair projects that involve harming and killing animals (Orlans 1993), and more harmful projects that receive no prizes. Though one million American students participate in mostly local science fairs yearly, much of what is known of animal use is from the two major science fair competitions in the United States: the International Science and Engineering Fair (ISEF), and the Intel Science Talent Search (ISTS, formerly the Westinghouse Science Talent Search, WSTS). Both of these science fairs are now funded by the Intel Corporation.

The WSTS began prohibiting invasive studies of vertebrates in 1969, in response to protest over a student’s prizewinning project that involved blinding sparrows that subsequently starved (blind birds will not move). The ISEF, in contrast, has continued to permit and even encourage invasive projects and has actively resisted attempts to prohibit such studies (Orlans 1993). A 1985 survey of ISEF projects found that when vertebrate animals were used, four of five projects involved harming the animals (Orlans 1988a). Twenty of the winning projects from ISEF’s 1985 and 1986 competitions involved demonstrations of the harmful effects of well-known toxic substances (ibid.). The 1999 ISEF included projects that had teenagers injecting animals with cancer cells, nicotine, high doses of antibiotics, or amphetamines, or exposing them to radiation (Opinion Research Corp. 1999). The permissiveness of this science fair sets an unfortunate example to lesser fairs.

Public sentiment disfavors the current status of animal use in science fairs. In a 1999 survey of 1,000 American adults, 79 percent disapproved of student science fair experiments that are harmful or painful to the animals, and 78 percent believed that science fair rules should be changed to prohibit such experiments (ORC 1999). Yet, as Morton (1987) observes, ISEF’s regulations appear to constitute poorer oversight of students than that required of scientists by the Animal Welfare Act.

Efforts by animal protection groups and/or concerned scientists to strengthen humane guidelines for science fairs continue. Orlans (1993) believes that secondary school students should not be permitted to inflict pain or a lingering death on vertebrate animals and that judgment of what may be appropriate use of animals should be left to students’ supervisors and IACUCs. For more than twenty years, the Women’s Humane Society, based in Bensalem, Pennsylvania, has been awarding “Humane Awards” for science fair projects that treat animals humanely, find alternatives to animal-based methods of research, and/or directly benefit animals. In 1998 this organization also presented its first “Humane Award” at the fiftieth ISEF, in Philadelphia.
5.6 HSUS Recommendations

1. School exercises that involve killing, undernourishing, or otherwise harming live animals should be replaced with humane alternatives, such as computer simulations, observational and behavioral field study, and benign investigations of the students themselves.

2. The traditional frog and turtle pithing exercises should be terminated and replaced with computer packages, which have been shown to save time and money without compromising educational value. Studies that involve the students as investigators and subjects should be more widely adopted.

3. Medical schools still using live terminal dog labs should follow the lead of other schools that have replaced these procedures with labs that employ a clinical approach with human patients.

4. Veterinary schools should accelerate the current trend towards replacement of purpose-bred and/or healthy animals with clinical cases for surgical training, including spay/neuter of shelter animals.

5. Recognizing that perioperative experience, including handling live tissue, is a critical part of a veterinary education, student participation in actual clinical cases coupled with primary surgical experience performing procedures of benefit to the animal (e.g., spay/neuter of shelter animals) should wholly replace traditional “survival” surgeries.

6. For common surgeries that are not medically required by an individual animal, only two options should exist: (1) terminal surgery on anesthetized, terminally ill animals with guardian consent or (2) cadaver surgery where cadavers are ethically obtained.

7. All science fairs should abide by a policy against inflicting deliberate harm on sentient animals.

8. Laws should be implemented that require a certain level of competency before a person is allowed to conduct animal experiments.

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1The IACUC granted full approval for these labs, and The HSUS filed a complaint with the university. Subsequent negotiations resulted in termination of the rabbit lab and a number of refinements being made to the mouse labs. The university’s IACUC chair and staff veterinarian showed considerable concern and willingness to work with The HSUS, but the persistence of the main portion of animal use in this course (the mice labs) illustrates the difficulties faced by a university in changing a tenured faculty member’s choice of teaching method. Naturally, there is a reluctance to criticize one’s peer, who is no doubt quite genuine in his/her belief that his/her personal choices of method are made with the highest educational goals in mind.