Table 2: Summary of Educational Objectives and Implementations Procedures With Vertebrates

Emotional: Students have an opportunity to nurture a creature of their choice through providing needs for life.

Social: Team efforts to nurture and to study vertebrates provide the context for group cooperation.

Intellectual: Gathering facts, elaborating processes, data-gathering, problem-solving presentation of a project are among the intellectual components associated with projects involving vertebrates.

Motivation: Certain vertebrates lend themselves to generating interest in biological activites among students who would otherwise be uninterested following a purely textbook approach.

Technical Skills:

1. Observing
2. Recording data in tables or in qualitative form
3. Investigating with a *control*
4. Manipulating equipment
5. Providing animal's needs

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Learning from Animals: Models for Studying Physiology and Disease

W. Jean Dodds

Abstract

Animals can serve as valuable educational tools for elementary and high school students. By teaching young people reverence for all forms of life at an early age, it is possible to instill in them a proper perspective concerning the welfare and humane stewardship of animals. Exemplary subjects include the various aspects of evolutionary and embryological development; normal physiological processes, the mechanisms and pathology of naturally occurring infectious, metabolic, genetic and neoplastic diseases and aging; and an appreciation of the inevitability of death. Such studies can serve as learning models for students because these processes parallel or closely resemble those of man. This approach teaches the ethics of animal usage and can be shown to result in benefits not only to humans but also to other animals. Although much has also been learned from research on experimentally-induced disease in animals, these techniques should be reserved for the appropriately supervised research laboratory and should not be practiced in the high school classroom.

Introduction

As a scientist with a deep-rooted love and compassion for living creatures, I am convinced, from my own experience, that research with animals can be humane as well as informative, and that such studies benefit not only mankind but also other animals. The answer to the current concern for humane care of animals, alleviance of pain and suffering, and reverence for all forms of life lies with our educational system. Children should be exposed to these principles in the home during early life. This contact can include the media via television and radio, books and magazines as well as parental guidance. One of the most important aspects is to teach children to be responsible for the care of animals—as, for example, with their own house pet. If this could be accomplished we will have reached the first step in preventing the accumulation of and need for mass euthanasia of unwanted dogs, cats, and other pets. The next opportunity for impact on the educational process is at the grade school and high school level. All children and young people should be taught about the basic biology, physiology, and behavior of animals and man, whether or not they intend to become involved with animals in later life. It is only by providing the proper setting and exposure to animals at this level that the scientist of tomorrow will be prepared to design

and execute meaningful and humane experiments on animals. A final point relates to the teaching methods, and qualifications and interests of the teachers. To initiate the challenge to learn and also instill the need for compassion when working with animals is a difficult task. It should be approached with dedication, sincerity, and above all, enthusiasm.

The paper to be presented here discusses noninterventive methods of learning from animals as models for studying physiology and disease. It will be restricted to mammals and will include their use to observe and study evolution, embryology and genetics, as well as the processes of normal physiology, spontaneous disease, aging and death.

Discussion

An important educational purpose is served by teaching reverence for all forms of life. This can start with learning about lower forms including plants, insects and unicellular organisms and progressing up the evolutionary scale to invertebrates, vertebrates and finally to mammals. A classroom introduction to mammals could begin by studying and comparing the behavior of marine mammals with that of terrestrial mammals and man. A variety of teaching methods can be used to exemplify the spectrum of the animal kingdom. These include direct observation and contact by means of classroom demonstrations and local or regional field trips to zoos, aquaria, farms, laboratory animal production facilities, wildlife preserves, humane societies, kennels, purebred animal shows and trails, veterinary clinics and animal training schools. Other techniques utilize communications-media, such as television, radio, books, magazines, films and lectures. Demonstration of normal physiological processes can be accomplished by direct or indirect means such as the study of embryological development in the chick embryo and films of mating behavior, parturition and maternal-neonatal interactions in a variety of species. The principle of genetics can readily be taught or demonstrated with plants and by studying coat color patterns in small laboratory rodents or in purebred dogs and cats.

Normal physiological processes of life and death can be illustrated by taking students to visit laboratory and farm animal production facilities. Observation of the rearing of suckling mice, rats, hamsters, guinea pigs, and rabbits in modern husbandry facilities gives the student an opportunity to appreciate humane care of laboratory animals, many of which are raised for use in biomedical research. Similarly a farm facility that produces livestock can illustrate lambing, kidding, and the hatching of newborn chicks, turkey poults and goslings.

Companion animals such as dogs and cats serve in the home and school as examples of the social interactions between people of different backgrounds and animals. Many young people have a family pet and have learned about life from watching and being involved in the birth and neonatal rearing of puppies and kittens. A common bond exists amongst peoples who love and work with animals and other forms of life. To a considerable degree rural and urban community life revolves around interactions with living things and hence these have significant impact.

Because of their shorter lifespan, various animal species provide excellent examples of the natural processes of aging and death. Too often the youngsters of today are shielded from exposure to disease, suffering, and death, and thus are completely unprepared to face this eventuality with their own pet, loved one or friend. Teaching the inevitability of death can be more easily accepted if the student learns respect and

compassion for all types of living things. Expression of grief under such circumstances should be encouraged as a normal emotional release.

A final and important educational opportunity is afforded by studying the naturally occurring inherited and acquired diseases of animals as well as the evolutionary differences between species as models for the analogous human situation. In this regard, the field of comparative hemostasis provides many examples which can be used as a powerful learning device. The following is a brief description of some selected examples.

All mammalian species studied to date have similar patterns and molecular weights of their platelet membrane glycoproteins with the exception of both wild and domestic members of the cat family (*Felidae*). None of these Felidae have detectable amounts of the major glycoprotein called glycoprotein I. This membrane component is thought to play a major role in platelet-blood vessel wall interaction, but apparently members of the cat family can function perfectly well without it. This and other species specific differences in platelet function have recently been reviewed by Dodds (1978a).

Sequencing analysis of the fibrinogen molecule of a variety of mammalian and nonmammalian species has revealed specific family-related differences, which permits extrapolation to the ancestral relationships between the various vertebrate and invertebrate classes (Gaffney, 1977; Doolittle, 1977). Similarly measurements of the relative activities and immunologic cross-reactions of identity, partial identity and non-identity between the clotting factor proteins of man and other mammals compares the activity and antigenic similarities and differences between these molecules (Bennett and Ratnoff, 1973; Ratnoff, 1977; Hawkey, 1976).

Acquired hemostatic disorders are recognized in both man and animals. The pathophysiology of these diseases is similar or identical in all species. For example, the infectious, metabolic, neoplastic, autoimmune and drug-induced causes of hemorrhagic tendencies have a common etiology and pathogenesis in a variety of mammals (Dodds, 1974; Dodds *et al.*, 1977; Raymond and Dodds, 1979).

Much more information is available on the inherited hemorragic diseases of animals than exists for acquired problems. Animal models have been recognized for nearly all of the coagulation and platelet function defects of humans (Dodds, 1974; Dodds, 1978b). The most common of these are the hemophilias (types A and B), which occur in nearly all purebreds of dogs, mongrel dogs, cats, and standard and thoroughbred horses, and von Willebrand's disease (VWD) which has been recognized in Poland-China swine, in six inbred families of purebred dogs, and in other isolated cases involving various breeds. The prevalence of the gene for VWD amongst inbred dog families is as high as 30-40% in Scottish terriers and Pembroke Welsh corgis and is more than 60% in Doberman pinschers. These genetic defects and their demographics in animal populations can be used to teach students the consequences of selection by intensive inbreeding and linebreeding.

Students can visit colonies of animals with such chronic genetic diseases and become volunteers to help with routine care, exercise and grooming. This affords a better appreciation of the complete dependency these animals have upon humans. Without someone to recognize and treat bleeding episodes when they begin, affected animals are helpless to protect themselves. Compassion for life and a dedication to the alleviance of suffering are easily developed by such an experience. In addition the students are performing an important and useful function as the emotional well-being of the afflicted animal is clearly enhanced by the attention, affection and social inter-

action. At the same time the reality of the serious nature of these genetic defects and the potential for severe illness or sudden death should be understood. The student can then appreciate that the best we hope for is to make what life these animals have as happy and meaningful as possible, while we learn from studying the natural course of their disease.

The above discussion illustrates one of many specific examples where animals with inherited diseases analogous to those of man can provide a challenging educational experience for the student.

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Reverence for Life: An Ethic for High School Biology Curricula

George K. Russell

Abstract

Ethical and pedagogical arguments are presented against the use of animals by high school students in experiments causing pain/suffering/death of the animal. No justification is seen for such experimentation when perfectly valid alternatives, using noninvasive techniques, exist or could be developed. An important concern is the emotional and psychological growth of young people. An overall objective of high school biology curricula must be to assist students in making viable connections with living biological processes and the natural world.

Introduction

In recent years, it has become increasingly common for high school biology students to make use of experimental procedures causing pain, suffering, and, in many cases, the death of vertebrate animals. Test reactions to toxic chemicals, deprivation diets, frog pithing and the removal of internal organs for physiological study, and other procedures have led to a growing concern among educators about the ethical and pedagogical value of these methods. To be sure, a commitment to "hands-on" learning and "inquiry-oriented" laboratory work is to be supported and encouraged, but at the same time one must seriously consider what is actually being done in the classroom and how it is done. The provision of living animals in high school classes for purposes of vivisection, for example, cannot be justified simply on the basis of an experiential learning approach; other more important aspects, including the humane treatment of sentient creatures and the emotional and psychological growth of young people, should be of much greater concern.

Reverence for Life: An Ethic for High School Biology

Thorough analysis of the relevant philosophical issues lies beyond the intended scope of this paper, but I should like to offer a fundamental ethical precept, which, I believe, could form the basis of a truly humane concern for vertebrate organisms in high school biology curricula. It is Albert Schweitzer's ethic of "reverence for life."

> *If (a human being) has been touched by the ethic of Reverence for Life, he injures and destroys life only under a necessity which he cannot avoid, and never from thoughtlessness. So far as he is a free man, he uses every oppor-*