cage. Illustrate diaphragmatic breathing simply by pulling down on the "diaphragm" with the "trachea" open. Observe the "lungs" filling, exemplifying inspiration, and while the "diaphragm" is being released, the "lung" empty, or expire. Actually, the diaphragm is curved upward at rest and taut at contraction.

This model may be used to illustrate the effects of occluding the trachea and respiratory opening. It also illustrates lung collapse resulting from a pneumothoracical wound. To do so, pull off the sealing tape covering the sidewall holes and operate the "diaphragm." Also, the "lungs" and/or the "diaphragm" may be punctured to allow observation of the ensuing results.

The simple model may serve as a demonstration for elucidating diaphragmatic and negative-pressure breathing. Discussions can be encouraged concerning chest (or thoracic) breathing as well as other areas of respiratory studies. Students may build or assemble prefabricated parts for individual laboratory studies. Clear tubes filled with colored water, and attached to the "trachea" may serve as manometers to illustrate the resultant pressure changes.

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# A Laboratory Exercise on Photoperiodic Changes in the Testes of the Mongolian Gerbil

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Fisher and Llewellyn (1978) report on the suitability of the Mongolian gerbil (*Meriones unguiculatus*) as a laboratory animal in the science classroom. Recent legislation in many states has, however, greatly restricted the use of vertebrates in science laboratory experiments (Animal Welfare Institute 1978). The National Science Teachers Association (1978) has also recently provided guidelines for teachers and their students in using vertebrate animals for experimentation. Furthermore, the works of Ryder (1975) and Singer (1975) dealing with the abuse of vertebrates by humans are becoming more popular. Similar recent publications focusing on the ethical issues underlying human treatment of animals by Regan and Singer (1976), Clark (1977), and Morris and Fox (1978) attempt to address more carefully, and with increased rationality, the moral status of animals and the effects of this status on our use of animals in laboratory experiments.

Almost nothing is known about the normal ecology of the gerbil, a native of Eastern Mongolia, Northeast China, and Western Manchuria, except that it is a burrowing animal living in arid regions. The gerbil is reported to be both day and night active (Walker 1964), and maintains body temperature within narrow limits (Robinson 1959); whether this animal is a hibernator is subject to debate (Theissen and Yahr 1977). It is likely, however, that during adverse winter conditions gerbils spend much of their time in lightless underground burrows; it might also be expected that under these conditions the gonads regress (Reiter 1974). This suggestion is supported by the observation that most litters are born between April and September following a gestation period of 25-29 days (Walker 1964).

An investigation was performed by Moos, Treagust, and Folk (1979) to examine the photoperiodic response of testicular development of the Mongolian gerbil and to determine the role that light might play in the animal's reproductive life. This investigation lends itself to adaptation for a secondary biology laboratory exercise and at the same time retains and nurtures a respect for animal life. The laboratory exercise described here should last about ten weeks and would appear to be a useful addition to any tenth-to-twelfth grade biology class dealing with animal behavior and/or animal function.

## Experimental Procedure

1. Divide twenty male gerbils approximately six weeks of age into two experimental groups; we found it convenient to house the gerbils five to a cage. Both groups should be placed in the same environment except for light: one group should experience constant darkness (D:D) and the other constant daylight (L:L)—in the original investigation we used a continuous light intensity of 60.5 foot candles. House all animals at the same air temperature, and hold other environmental conditions, such as noise and humidity, constant. The animals in our investigation were fed Purina rat chow (a "complete" food) and water *ad libidum*. Carefully mark each gerbil to distinguish it either by tail markings in ink or cutting small hair patches. Don't forget to record the markings and check them each week for clarity.

2. Every week during the ten week experimental period weigh each animal and measure the length and width of the right (or left) testis through the skin using a pair of calipers. Record these measurements in millimeters by laying the calipers against a rule. Select the same day each week, and the same time of day, when the measurements can be taken. Half the class (working in pairs) can measure each gerbil in the L:L group and the other half of the class can measure each gerbil in the D:D group. From our experience, it is unlikely that the gerbils will bite when they are held for measurements, but as a precaution, a leather glove could be worn by the more timid handlers.

3. Each week, or following the entire experimental period of ten weeks, the volumes of each gerbil's testis should be calculated by the student-pairs, using the formula for an oblate spheroid, $v = 4/3 \; \pi ab^2$, where $a$ is the major radius (length) and $b$ is the minor radius (width). Calculate the mean values for weight and testicular volume for each gerbil from the data of each student-pair each week.

4. As it is standard practice to measure body organs in relation to body weight in longitudinal studies, calculate the ratio of mean value of testicular volume (in $mm^3$) to body weight (in grams) per week for each gerbil. This ratio can now be plotted on a graph over the ten week period for all ten L:L and D:D animals. We recommend a separate plot for mean body weight for comparison of weight variability with testicular volume/body weight variability. Comparison of plots between gerbils housed in constant light and in constant darkness are reviewed. In our investigation we observed distinguishable differences in favor of testicular inhibition during the dark conditions (Moos, Treagust, and Folk 1979).

Our results, which were based on mean values for the ten gerbils in both experimental conditions, revealed wide fluctuations in the ratio values throughout the experimental period. Peaks in values occurred in the fifth, eighth, and tenth weeks in both groups, and low values were observed in both groups in the sixth and ninth weeks. The fluctuations in ratio values seemed to reflect, at least in part, rhythmic fluctuations in the body weight. This phenomenon of fluctuating body weight has previously been observed in hamsters (Folk and Farrand 1957), and it is conceivable that the testes may undergo normal rhythmic variation in size as well.

The results of our investigation indicated that the Mongolian gerbil shows a photoperiodic response; the animals kept in constant dark conditions showed inhibition of testicular development. The result was in accord with our expectations from comparative rodent data (Reiter 1974); it is likely that under conditions of decreased light, i.e., winter, testicular development of the Mongolian gerbil is inhibited.

This type of experiment provides each student with an experience in handling gerbils and will help develop a positive attitude toward experimenting with laboratory animals that is consistent with state regulations, NSTA guidelines and the growing awareness of the moral status of animals.

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