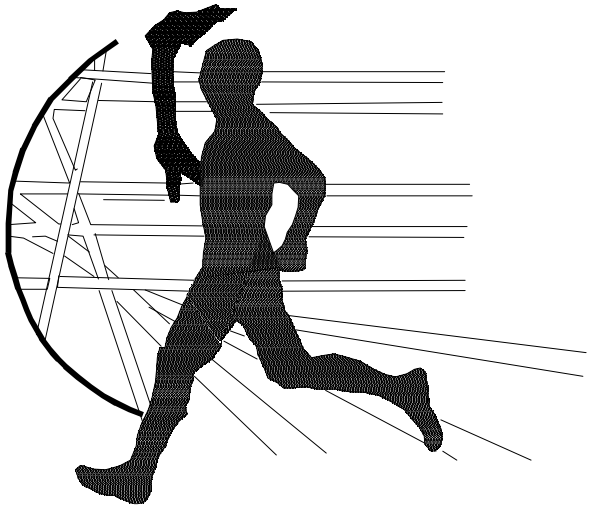

London and District Science Olympics

Annual Competition

AMAZING RODENTS

Biology - Open

Thames Valley District School Board

London District Science and Technology Fair Inc

The London District Catholic School Board

Faculty of Science - *The* University *of* Western Ontario

http://www.physics.uwo.ca/olympics/olympics.htm

AMAZING RODENTS

RULES

Biology

Each team will construct a standard maze according to specifications provided. The team will obtain a mouse, hamster, or gerbil and train it to run the standard maze. The competition maze is white. The end boxes are open and covered with wire. Teams may not touch the maze or the animal during the trial. Rats are not permitted in this competition.

A training log must be kept by each team, and signed by each member to confirm that it is an accurate record of the training program, and that the Guiding Principles of the Canadian Council on Animal Care have been followed. It must describe:

a. Feeding times.
b. Where the animal was housed.
c. How often it was handled.
d. Who handled it.
e. Dates, times and results of each training session

Students will be interviewed and tested on their knowledge of Animal Care. If, in the opinion of the Judges, the Guiding Principles of the Canadian Council on Animal Care have not been followed, the team will be disqualified.

The training log must be submitted by email to Leslie Gray-Statchuk, leslie.graystatchuk@lhsc.on.ca by the Friday prior to the Olympics. The log must be submitted in WordPerfect format, and **attached** to the email message.

A hard copy of the log, signed by the members of the team, must be brought on the day of the Olympics. Teams not submitting a signed training log will not be allowed to enter. The template for the training log is available on the web site, and this template must be used.

Open to all students

On the day of the competition, the animal will be timed on his/her running of a standard maze.

i. Each animal will be allowed 3 trials in the Standard Maze.
ii. Each wrong turn will be assessed a 5 second penalty.
iii. Each trial will cease after 90 seconds. The maximum time score is 90 seconds.
iv. The animal with the lowest time including penalties will be declared the winner of the maze running competition.

If a school wishes, more than one animal may be entered, but each school will be allowed a total of three trials only. The school log score will be the average of the individual Log scores. Logs will not be returned.

The marks from the maze running will be scaled so that the lowest time L scores 80 points and the longest time H scores 20 points. If your animal scores a time T, the formula for your score is given by:

$$\text{Your score} = \frac{80H - 20L - 60T}{(H - L)}$$

v. The final score will be calculated as follows:
Run: 80%; Log: 10%; Quiz: 10%.

1. BACKGROUND

The use of animal subjects in the study of learning began more than 80 years ago when Small (1899) tested rats in a reproduction of the famous maze at Hampton Court in England (Fig. 1).

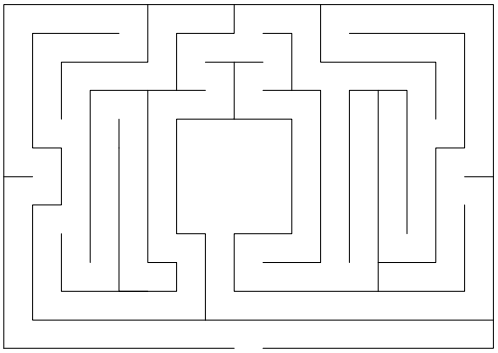

Figure 1 *The Maze at Hampton Court Palace*

This was the first use of a maze as a research device for studying animal learning. Although operant conditioning techniques are now generally preferred for such studies, many ethnologists and animal psychologists still use mazes for experiments involving a variety of animals. (See the reference list for some representative recent publications.)

2. SOME BASIC CONCEPTS

Although Small's experiments proved that rats can master a very complicated maze, subsequent investigators simplified the maze pattern and standardized the experimental procedures. The techniques used in maze studies can be easily explained with reference to a T maze (Fig. 2), one of the simplest mazes to construct and use.

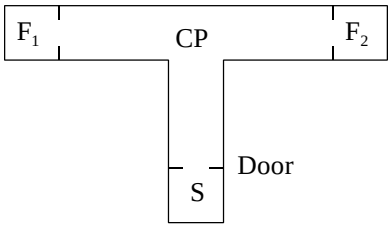

Figure 2 *A simple T maze with a single choice point*

In T maze experiments the test animal is placed in the starting box (S) and food is put in one of the food boxes (F1 or F2). The first trial begins when the door leading from the starting box to the stem of the maze is opened. Note the choice point (CP) where the animal must turn either left or right. If the food is present in F1, the correct run sequence would then be SF1. In other words, the animal must move directly from the starting box to the choice point, and then make a left turn and go directly to the food box. If the animal turns right at the choice point and goes to F2, this constitutes an error. Since there is no food at F2, the animal will eventually leave that box and move toward F1. Entry of F1 completes the first trial. If the animal turns left at the choice point after leaving F2, another error would be scored.

An **error** is therefore defined as any turn away from the correct path leading from the starting box to the food box.

After a brief period in the food box, the animal is again placed in the starting box, and after a rest period of one or two minutes, the second trial begins. The trials are repeated until the animal either demonstrates that it has learned the maze, or that it has not been able to master the problem within a predetermined number of trials. In the latter case, the animal is considered to be a failure. How can we quantify the animal's maze performance and judge whether or not learning has occurred?

3. SCORING

There are several ways to quantify an animal's performance in a maze. Four scores commonly used are described below.

a. Running time.

A stopwatch or other timing device is used to determine the time required for the animal to move from the starting box to the food box. The graph of the running time for each successive trial represents a learning curve.

A typical learning curve determined for mice given 12 trials in a T maze is shown in Fig. 3.

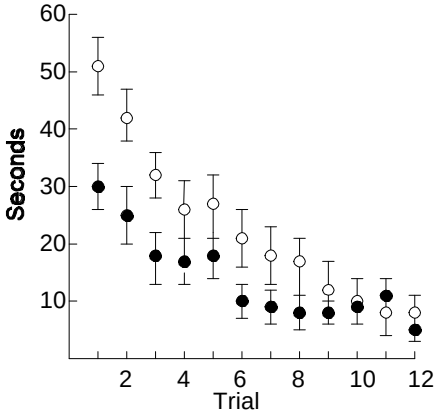

Figure 3 *Average running time for white mice during the first (open circles) and the second (closed circles) series of trials in a T maze.*

Note the decrease in running time with increasing number of trials in the maze. Why does the curve never intersect the X-axis of the graph ? Also notice in this experiment that when these mice were retested in the maze after one month, the learning curve was shifted down on Y-axis of the graph. How can you account for this shift?

b. Trials to criterion.

This arbitrary performance standard is set by the investigator who regards it as a reliable indication that learning has taken place. How tough will you be? Will you insist that eight errorless trials in sequence represent significant learning, or will you settle for five such trials? How about seven perfect in a sequence of ten? Assume that we set our criterion at seven correct (errorless) trials in a sequence. Once again with respect to our simple T maze, it is possible that a given animal might go directly to F1 each time that it is placed in the maze. It would therefore reach criterion in seven trials, or in other words, the number of trials to criterion would be seven.

Most rodents are not so clever; they will make many errors during the first few trials in the maze. Suppose a second animal makes errors during the first, second, third and fourth trials, but goes directly to the food box on the fifth trial. If it now has six more errorless trials, the number of trials to criterion for this animal would therefore be eleven.

c. Time to criterion.

The total working time elapsed before criterion is reached is also a useful statistic to use in the assessment of learning. This can be calculated by summing the running times for all the trials required to reach criterion.

d. Errors to criterion.

Keep track of those wrong turns! Add up the total number of errors made by the animal before it reached criterion. This is a good indication of how "bright" your test animal is.

4. SELECTION OF ANIMALS

Depending on what species of small mammals are readily available either from your classroom, or as pets from home, you may prefer to use gerbils, mice or hamsters for your study. Rats may not be used in this event. Realize that some species may perform better than others. Indeed, use gerbils with caution. These animals are curious creatures, and they may spend a long time simply exploring every corner of your maze. Since the object of this event is to train an animal to run a standard maze in the shortest time possible, you may not want to pin your hopes on an animal that wanders through the maze casually checking out every corner and blind alley.

In addition to inter-specific differences, learning ability can also vary between different individuals within a given species. It has been known for many years that maze-learning ability in rats is inherited. If "smart" rats are mated with only "maze-bright" partners, and "dumb" rats are mated with "maze-dull" animals, two genetically distinct lines of bright and dull rats can be produced (Tryon, 1940). It would therefore be wise to conduct preliminary maze trials with several different animals of the same species in an effort to select a maze-bright subject for further training. If time permits, you might also like to conduct a breeding experiment to select for maze-bright animals.

5. MAZE DESIGN

For this event you will train an animal to perform in a U maze (Figs. 4,5).

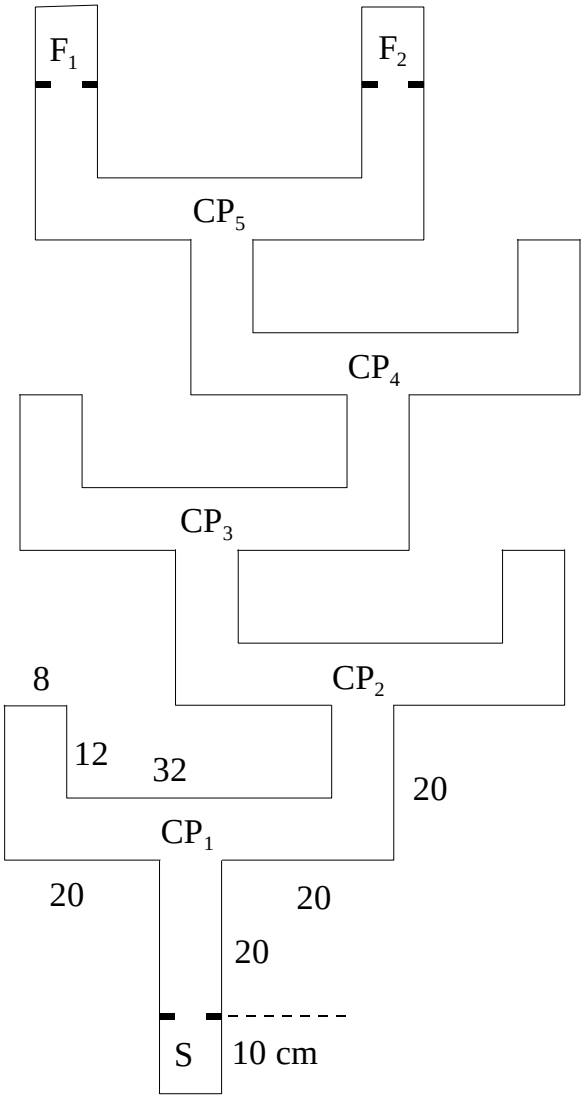

Figure 4 *Design of the standard U maze used at the Science Olympics. Dimensions are in cm.*

The U maze is a modified T maze with an extra corner at the end of each arm to conceal the blind alley from the animal when it reaches a choice point. Note that this maze has five choice points.

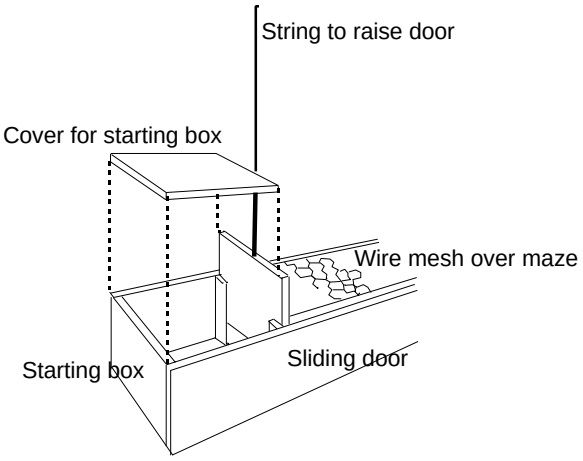

Figure 5 *Details of the Maze construction*

The maze can be constructed from scrap plywood. If you use the "good-one-side" grade, make sure the good side is used for the inner walls and the floor. These should be painted white. Use a paint that can be washed; you will need to clean the maze thoroughly after each training session. To make the cleaning easier, you may wish to coat the walls and floor of the maze with clear plastic (use lacquer spray).

The runways of the maze are 8 cm wide and 8 cm high. The starting box measures 8 cm by 8 cm by 10 cm, and connects with the first alley by a guillotine door that can be raised by a string or wire connected to an overhead pulley. The starting box has a wooden cover. This is to keep the test animal in a darkened area until the door opens. To prevent the animal from escaping, the rest of the maze is covered with a piece of 1/2 inch poultry mesh. The mesh is attached to a wooden frame measuring 68 by 130 cm, that fits over the entire maze (except the starting box), and can be removed when the maze is cleaned. For these learning experiments, a food reward will be placed in F2. This might be a few seeds or raisins - whatever appeals to your particular animal. The correct turn sequence at the choice points of our standard maze will then be: R,L,R,L, and R. This is a difficult sequence for rodents to learn because they typically make alternate left and right turns in locomotion, that is, they have a tendency to dodge alternatively to the left and right instead of turning repeatedly to the same side.

In a U maze, each choice point beyond the first is immediately preceded by a forced turn to the left or the right, and the animal's tendency is to choose the reverse turn at the choice point. Therefore, if the animal turns right at CP1, it must then turn left and proceed to CP2. The animal's natural tendency is to follow this left turn with a right turn at CP2 which would lead it to a blind alley. If you apply this logic to the rest of the maze, you will see that the animal must overcome this natural tendency to alternate left and right turns if it is to avoid blind alleys and learn the correct maze sequence.

Begin your experiment by placing the test animal in the starting box. Check to be sure there is a food reward in the food box, and that the doors leading to the food boxes are raised. Open the door of the starting box and activate the timer. Count the number of errors made by the animal as it explores the maze. Stop the timer when the animal enters the food box, and lower the door. Record the running time for the first trial. Permit the animal to remain in the food box for one minute, then return it to the starting box. Open the starting box door after one minute and begin timing the second trial. Again, record the errors made by the animal as it moves through the maze.

Repeat the trials until the animal has either

reached criterion, or is classified as a failure if it fails to reach criterion within a predetermined number of trials. When the experiment is finished, clean the maze and remove all traces of urine and faeces. This is very important because any olfactory clues left in the maze may affect the performance of the next animal to be tested.

Prepare a learning curve for your animal trainees by plotting running times and numbers of errors against trial number. Calculate time to criterion and errors to criterion. Repeat the learning trials until you are confident that you have a well- trained rodent capable of representing your school.

6. ANIMAL CARE AND HANDLING

Biological experimentation involving animals in the classroom is essential for an understanding of living processes. Such studies should lead to a respect for all living things. It is mandatory that you provide your animals with comfortable cages, an adequate supply of nutritious food and clean drinking water.

It must also be recognized that frightened, disturbed animals will not respond normally. Select a member of your team who is comfortable handling animals, and give him/her the job of removing the animal from its cage and placing it in the maze. Keep the room quiet during the maze trials. If possible, minimize the disturbance to the animal by observing it form a distance by means of an overhead mirror.

Scientists who study animal behaviour realize the extreme importance of working with healthy animals that are not subjected to unnecessary stress. It is both morally and scientifically important to provide the best possible care for your experimental animals.

The Canadian Council on Animal Care (CCAC) has provided a list of guiding principles governing the use of animals in the classroom. Consult the attached guideline before you begin your project, and follow them during the course of your learning studies.

7. REFERENCES:

Devenport, L.D., Merriman, V.J. and J.A. Devenport. 1983. *Effects of ethanol on forced spatial variability in the 8-arm radial maze*. Pharm. Biochem. Behaviour. 18:55-59.

Golczewski J.A., Hiramoto R.N. and Ghanta V.K. 1981. *Enhancement of maze learning in old C57BL/b mice by dietary lecithin*. Neurobiology of Aging. 3:223-226.

Kessler, J., Markowitsch H.J. and Otto B., 1982. *Subtle but distinct impairment of rats with chemical lesions in the thalamic mediodorsal nucleus, tested in a radial arm maze.* J. Comp. Psych. 96:712-720.

Kinjoh, T. 1981. *Effect of food deprivation on maze and discrimination learning in white rats.* Ann. Animal Psychol. (Japan) 31:11-24.

Small, W.S. 1899-1900. *An experimental study of the metal processes of the rat.* Amer. J. of Psych. 11:133-164.

Tryon, R.C. 1940. *Genetic differences in maze learning in rats*. National Soc. for the Study of Education, 39th Yearbook. Public School Publishing, Bloomington, Illinois.

Woodworth, R.S. and Scholsberg, H. 1954. *Experimental Psychology*. Holt, Rinehart and Winston, New York, 948 pp. (see Chapter 21 on maze learning).

8. CANADIAN COUNCIL ON ANIMAL CARE

Guiding Principles Governing the Use of Animals in the Classroom at the Pre University Level

a. Purpose

These guiding principles have been prepared by the Canadian Council on Animal Care. They are recommended for use by Departments of Education and Boards of Education across Canada in order to ensure adequate safeguards exist for the proper care and use of animals in experimentation in the classroom, in the schools, in their jurisdiction.

These guidelines are not for use by students preparing projects for exhibit in Science Fairs. Students preparing projects for Science "Fairs must adhere to the Youth Science Fair Regulations for Animal Experimentation, as prepared and distributed by the Youth Science Foundation, Suite 302, 151 Slater St., Ottawa K1P 5H3

b. Philosophical Considerations

Biological Experimentation involving animals in the classroom is essential for an understanding of living processes. Such studies should lead to a respect for all living things. All aspects of the study must be within the comprehension and capabilities of the student undertaking the study.

Lower orders of life are preferable subjects for experimentation at the pre-university level. Such lower orders as bacteria, fungi, protozoa, and insects can reveal much basic biological information; they should bee used for experimentation , wherever and whenever possible.

c. Care of experimental animals

The care of experimental animals in the school should embody the principles laid down in this Guide.

The following principles are necessary in order to provide optimal animal care:-

i. The maintenance of animals in a classroom shared by students on a long term basis, is not recommended. Therefore animal quarters specifically for housing animals should be provided.

ii. All experimental animals used in teaching programs must be properly cared for. Animal quarters should be made comfortable by provisions for sanitation, protection from the elements and have sufficient space for normal behaviour and postural requirements for the species. The living quarters shall have surfaces that may be easily cleaned, good ventilation and lighting, well regulated temperatures and cages of sufficient size to prevent overcrowding. Animals must be protected from direct sunlight or other environmental factors which may disturb the well-being of the animal.

iii. Food should be palatable, of sufficient quantity and balance to maintain a good standard of nutrition. Animals shall not be allowed to go below the maintenance level of nutrition. Clean drinking water shall be available at all times. Containers for food and water should be of a design, made specifically for that purpose.

iv. Colonies and animal quarters shall be supervised by a science teacher experienced in animal care. The students and other

animal care staff shall be trained, and required to handle the animals gently and humanely.

v. All animals must be disposed of in a humane manner. If euthanasia has to be carried out an approved humane method must be used and carried out by an adult experienced in the use of such procedures.

vi. The use of animals must comply with existing local, provincial or Federal legislation.

vii. The procurement and use of wild animals and birds must comply with the Migratory Birds Convention Act of Canada, the Convention on International Trade on Endangered Species of Wild Fauna & Flora (ratified by Order in Council July 3/75) as well as any existing legislation at the Provincial level concerned with wild animals and exotic species.

d. Experimental Studies

i. All experiments should be carried out under the supervision of a competent Science Teacher. It is the responsibility of the qualified science teacher to ensure that the student has the necessary comprehension for the study to be undertaken.

ii. Students should not be allowed to take animals home to carry out experimental studies. All studies involving animals must be carried out in a suitable area in the school.

iii. All students carrying out projects involving vertebrate animals must adhere to the following guidelines:-

(1) No experimental procedures shall be attempted on a vertebrate animal that should subject it to pain or distinct discomfort, or interferes with it's health.

(2) Students shall not perform surgery on vertebrate animals.

(3) Experimental procedures shall not involve the use of:-

- microorganisms that can cause diseases in people or animals
- ionizing radiation
- cancer producing agents
- alcohol in any form
- drugs that may produce pain
- drugs known to produce adverse reactions, side effects, or capable of producing birth deformities.

(4) Experimental treatments should not include electric shock, exercise until exhaustion, or other distressing stimuli.

(5) Behavioural studies should use only reward (positive reinforcement) and not punishment in training programs.

(6) If egg embryos are subjected to experimental manipulations , the embryo must be destroyed humanely 2 days prior to hatching. If normal egg embryos are to be hatched , satisfactory humane considerations must be made for disposing of the young birds.

iv. The use of anaesthetic agents by students is not recommended and in the case of some anaesthetics is not permitted by law.

v. Information on the care, housing and management for individual species, as well as suitable experiments for use at the pre university level, may be obtained from the Canadian Council on Animal Care, 151 Slater St., Suite 1105, Ottawa Ont. K1P 5H3.

Amazing Rodents Training Log

Name of your School_____

Name of your Animal_____

Team Members

By signing this log in the table below, we declare that the rules of the event have been followed, including particularly the Guiding Principles of the Canadian Council on Animal Care.

	Name	Signature
1		
2		
3		
4		
5		
6		

1. Where was the animal housed?

2. How often was the animal handled?

3. Who handled it?

4. What were the feeding times?

Training Sessions		
Date	**Time**	**Description**