LABORATORY EXERCISE USING "VIRTUAL RATS" TO TEACH ENDOCRINE PHYSIOLOGY

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A nimal experimentation is limited in many curricula due to the expense, lack of adequate animal facilities and equipment, and limited experience of the teachers. There are also ethical concerns dealing with the comfort and safety of the animals. To overcome these obstacles, we developed a "dry laboratory" using "virtual rats." The "virtual rat" eliminates the obstacles inherent in animal experimentation, such as inadequate budgets, as well as avoiding important animal rights issues. Furthermore, no special materials are required for the completion of this exercise. Our goal in developing this dry laboratory was to create an experience that would provide sude to with an appreciation for the value of laboratory data collection and the ysit. Students are exposed to the challenge of animal experimentation, be issues surrounding the use of live animals. M. J. PHYSIOL 273 (ADVERTISED) DVC. 18): 524-540, 1997

The most effective means by which physiology is learned is through active participation in laboratory experimentation and analysis (2). However, experimentation is often neglected in many curricula due to the scarcity of suitable laboratory equipment, space, and experiments. The use of laboratory animals for experimentation is another obstacle because many schools do not have sufficient funding or facilities to care for live animals. In addition, some teachers may lack the experience of handling laboratory animals.

To promote laboratory experimentation, we developed a "dry laboratory" using "virtual rats." This dry laboratory is a complete experiment without additional expense, because no animals or special equipment are required for its completion. The virtual rat avoids the complications associated with the use of animals by graphically demonstrating the changes that would be observed in living animals had the experiment actually taken place. Our purpose in creating this educational tool was to develop an experience that provides an opportunity for students to explore the realm of laboratory experimentation. We have eliminated the need for special equipment or facilities. This experiment provides an opportunity for students to actively learn physiology through the collection, analysis, and interpretation of data.

The experience is designed so that students first learn the basic physiological concepts behind the endocrine system. Because of its complex and specialized nature, little experimental material for endocrine physiology exists. We have provided a less complicated means by which students are able to learn about the endocrine system. Questions within the text supplement the laboratory and promote the students' understanding of major concepts. After learning the physiological principles, the students are presented

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with an experimental design that involves the identification of an unknown hormone. The students are encouraged to complete a table that describes the effects of each hormone, thus presenting the student with a chance for small group discussion. An array of measurements are performed on the virtual rats to provide the experimental data needed. This data is presented to the students, who must use their knowledge of the endocrine system to correctly identify the unknown hormone.

Our intent for the students on completion of the experiment is to have an understanding of important physiological concepts and appreciation of laboratory data analysis. Students are able to learn more effectively if they are involved in their own education and become active, independent learners and problem solvers (3). Through this experience, we provide an opportunity for students to become active learners through small group discussion, analytic thinking, and the collection and interpretation of laboratory data. Our hope is to spark interest for future study in the field of physiology by presenting material in a thought provoking, challenging, and inexpensive an any wile encouraging the students to the content independent learners.

LABORATORY EXERCISE

Objectives

A) To introduce the relationship between the hypothalamus and the pituitary gland;

B) To introduce various hormones and explain their effects;

C) To encourage small group discussion and enhance analytic thinking;

D) To have the student apply what he or she has learned to an experimental situation by identifying an unknown hormone.

Materials Needed

No materials are needed.

Time Required

Three hours is the time recommended for the completion of this exercise.

BACKGROUND AND KEY TERMS RELATED TO THIS EXERCISE

Questions are integrated throughout the text to serve as a source of discussion and aid in the understanding of key points. Questions marked with arrows (\rightarrow) are used to review the previous passage, and questions marked with asterisks (**) are used to provoke thought on upcoming passages.

The organs of the body communicate with each other through the nervous and endocrine systems to coordinate their activities. The **nervous system** uses neurotransmitters and neurons to convey information to and from the brain. In contrast, the **endocrine system** uses how ones, which are chemical messengers produced by specific tissues in the body, to on is at information. These hormones travel through the bloodstreap to exert their effects on distant target organ.

In a similar manner, people communicate with each other by using telephones and the postal service. The body's nervous system is comparable to the telephone system because it sends fast, direct messages. The endocrine system is comparable to the postal service because the delivery of the message is slower. Like bulk mail, the message is more diffuse (reaches a greater area) and affects more than one person or organ. Although the hormone travels through the body via the blood, it can only affect those cells with receptors for that specific hormone. Hormones are a slower method of communication, but their effects last longer.

The command center for the endocrine system is the **hypothalamus**, a small, penny-sized portion of the brain. The hypothalamus acts as an endocrine organ that secretes oxytocin and anti-diuretic hormone (**ADH**, also known as vasopressin). These hormones travel down the pituitary stalk to the posterior pituitary gland where they are released directly into the bloodstream. In addition, the hypothalamus also regulates anterior pituitary gland function through the



FIG. 11. Autopsy results from rats treated with *hormone 4*.

•Stimulates the breakdown of proteins and fats and helps the body adapt to stress.

•Can function as an anti-inflammatory drug and an immunosuppressive (therefore, when in excess, cortisol will cause a decrease in immune system function).

7) The role of LH is different in males and females. In males, LH travels to the Leydig cells to allow the

release of testosterone. Testosterone is responsible for the males' secondary sex characteristics. In females, LH causes the follicle in the ovary to secrete estrogen. Estrogen is responsible for the females' secondary sex characteristics.

8) LH positive feedback, seen in the females, causes the follicle to release estrogen. Estrogen feeds back to the anterior pituitary gland to cause an increase in LH