Endocrine System Physiology

PhysioEx [tm] 9.0, Exercise # 4, Activities 3 and 4

Materials:

Group Supplies

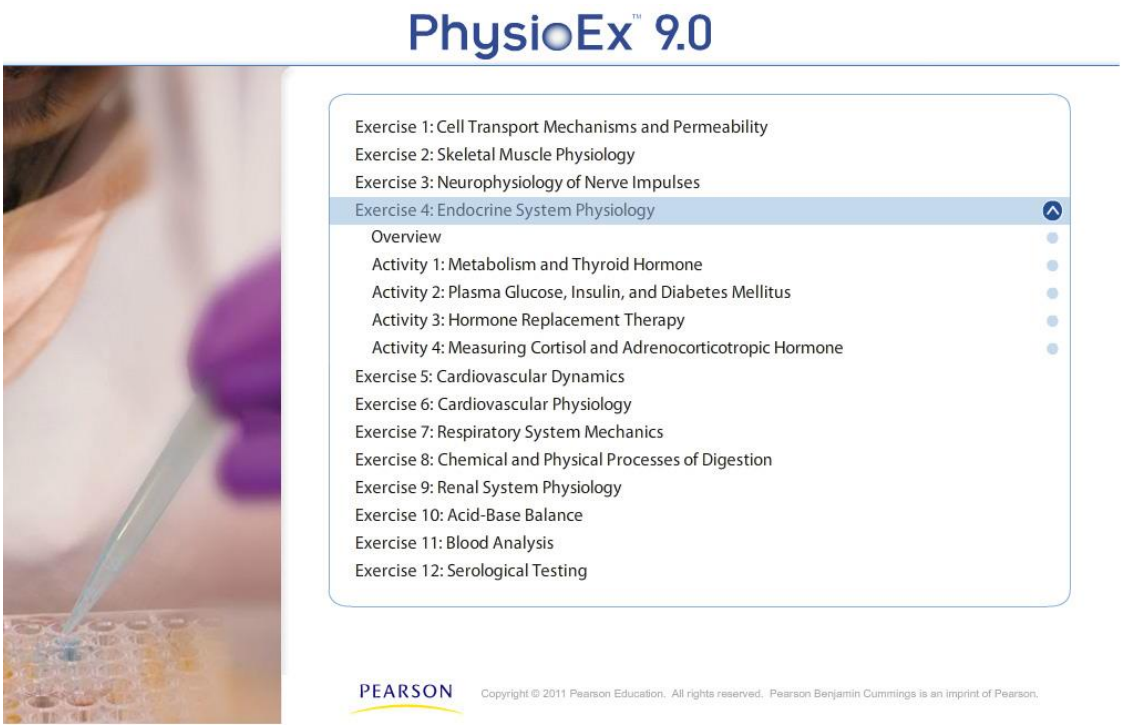
Computer with PEX9 installed.

Methods:

Double click the shortcut named PEx to select PhysioEx 9.0: an application for simulating physiology experiments.

Select: "Access PhysioEx 9.0 to get started!"

Select: "Exercise 4: Endocrine Physiology" (and then **Activities 3 and 4**.)



Select: "**Activity 3: Hormone Replacement Therapy**

Read the Objectives and Introduction.

Objectives:

1. To understand the terms hormone replacement therapy, follicle stimulating hormone (FSH), estrogen, calcitonin, osteoporosis, ovariectomized, and T score.
2. To understand how estrogen levels affect bone density.
3. To understand the potemyial benefits of hormone replacement therapy.

Introduction:

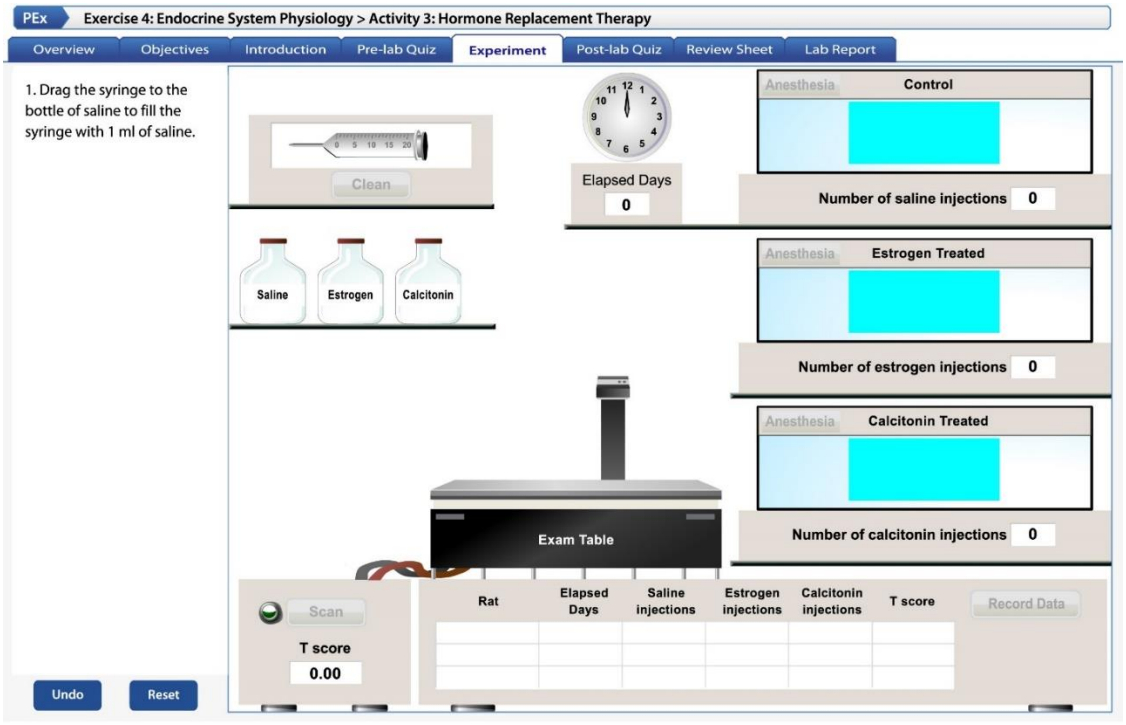
Follicle-stimulating hormone (FSH) is an anterior pituitary peptide hormone that stimulates ovarian follicle growth. Developing ovarian follicles then produce and secrete a steroid hormone called estrogen into the plasma. Estrogen has numerous effects on the female body and homeostasis, including the stimulation of bone growth and protection against osteoporosis (a reduction in the quantity of bone characterized by decreased bone mass and increased susceptibility to fractures).

After menopause, the ovaries stop producing and secreting estrogen. One of the effects and potential health problems of menopause is a loss of bone density that can result in osteoporosis and bone fractures. For this reason, postmenopausal treatments to prevent osteoporosis often include hormone-replacement therapy. Estrogen can be administered to increase bone density. Calcitonin (secreted by C cells in the thyroid gland) is another peptide hormone that can be administered to counteract the development of osteoporosis. Calcitonin inhibits osteoclast activity and stimulates calcium uptake and deposition in long bones.

In this activity you will use three ovariectomized rats that are no longer producing estrogen because their ovaries have been surgically removed. A T score is a quantitative measurement of the mineral content of bone, used as an indicator of the structural strength of the bone and as a screen for osteoporosis. The three rats were chosen because each has a baseline T score of -2.61, indicating osteoporosis. T scores are interpreted as follows: normal = +1 to -0.99; osteopenia (bone thinning) = -1.0 to -2.49; osteoporosis= -2.5 and below.

You will administer either estrogen therapy or calcitonin therapy to these rats, representing two types of hormone-replacement therapy. The third rat will serve as an untreated control and receive daily injections of saline. The vertebral bone density (VBD) of each rat will be measured with dual X-ray absorptiometry (DXA) to obtain its T score after treatment.

Do the Pre-Lab Quiz, Experiment, and Post-Lab Quiz.



Select: "**Activity 4: Measuring Cortisol and Adrenocorticotropic Hormone**"

Read the Objectives and Introduction.

Objectives:

1. To understand the terms cortisol, adrenocorticotropic hormone (ACTH), corticotropin-releasing hormone (CRH), Cushing's syndrome, iatrogenic, Cushing's disease, and Addison's disease.
2. To understand hoe CRH controls ACTH secretion and ACTH controls cortisol secretion.
3. To understand how negative feedback mechanisms influemce the levels of tropic CRH and ACTH.
4. To measure the blood levels of cortisol and ACTH in five patients and correlate these readings with symptoms and diagnoses.
5. To distinguish between Cushing's syndrome and Cushing's disease.

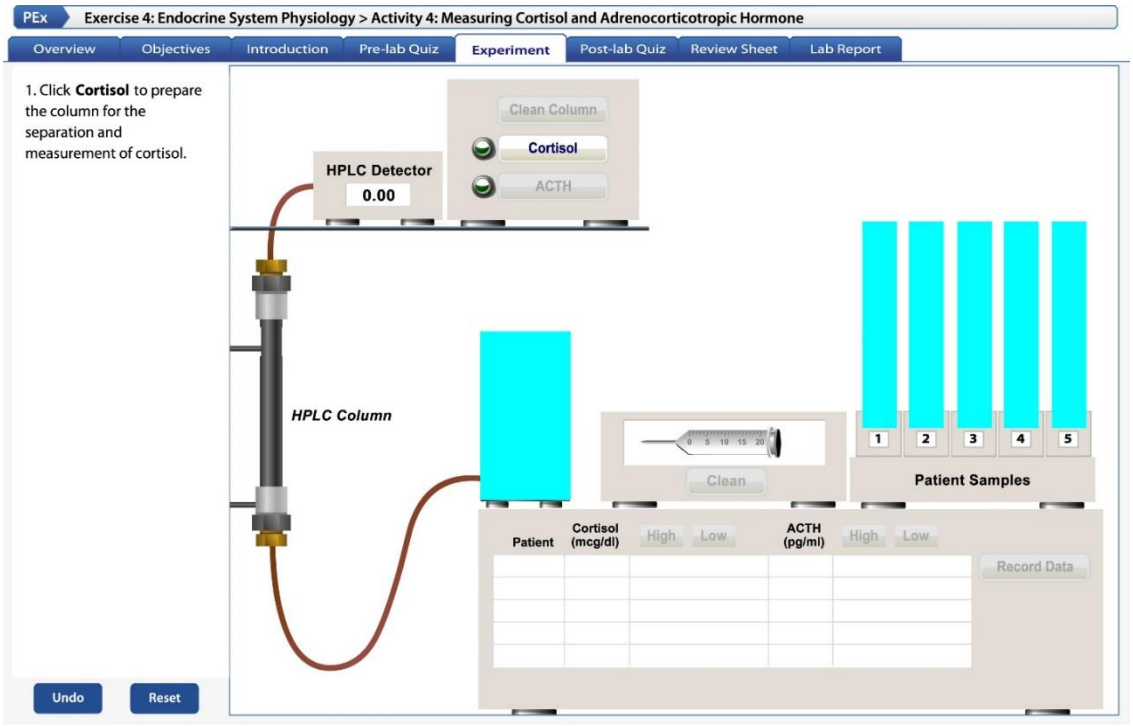
Introduction:

Cortisol, a hormone secreted by the adrenal cortex, is important in the body's response to many kinds of stress. Cortisol release is stimulated by adrenocorticotropic hormone (ACTH), a tropic hormone released by the anterior pituitary. A tropic hormone stimulates the secretion of another hormone. ACTH release, in turn, is stimulated by corticotropin-releasing hormone (CRH), a tropic hormone from the hypothalamus. Increased levels of cortisol negatively feedback to inhibit the release of both ACTH and CRH (view Figure 4.6).

Increased cortisol in the blood or hypercortisolism, is referred to as Cushing's syndrome if the increase is caused by an adrenal gland tumor. Cushing's syndrome can also be iatrogenic {that is, physician induced). For example, physician-induced Cushing's syndrome can occur when glucocorticoid hormones, such as prednisone, are administered to treat rheumatoid arthritis, asthma, or lupus. Cushing's syndrome is often referred to as "steroid diabetes" because it results in hyperglycemia. In contrast, Cushing's disease is hypercortisolism caused by an anterior pituitary tumor. People with Cushing's disease exhibit increased levels of ACTH and cortisol.

Decreased cortisol in the blood, or hypocortisolism, can occur because of adrenal insufficiency. In primary adrenal insufficiency, also known as Addison's disease, the low cortisol is directly caused by gradual destruction of the adrenal cortex and ACTH levels are typically elevated as a compensatory effect. Secondary adrenal insufficiency also results in low levels of cortisol1 usually caused by damage to the anterior pituitary. Therefore, the levels of ACTH are also low in secondary adrenal insufficiency. As you can see, a variety of endocrine disorders can be related to both high and low levels of cortisol and ACTH. Table 4.1 summarizes these endocrine disorders (view Table 4.1).

Do the Pre-Lab Quiz, Experiment, and Post-Lab Quiz.



Discussion:

Activity 3: Hormone Replacement Therapy

1. Explain the role of Estrogen from the ovary and Calcitonin from the thyroid in protecting against osteoporosis.
2. Explain the role of Follicle Stimulating Hormone (FSH) from the anterior pituitary, in the control of Estrogen from the ovary.
3. Explain the cause of osteoporosis.

Activity 4: Measuring Cortisol and Adrenocorticotropic Hormone

4. Explain the role of Cortisol from the adrenal cortex in coordinating the body's responses to stress.
5. Explain the role of CRH from the hypothalamus and ACTH (Corticotropin) from the anterior pituitary, in the control of Cortisol from the adrenal cortex.
6. Explain the role of Cortisol in providing negative feedback control of CRH from the hypothalamus.
7. Explain Cushing's Disease, Cushing's Syndrome, and Addison's Disease