NATIONAL REVIEW COURSE

Endocrine System

I. Introduction
   A. The endocrine and nervous systems function to achieve and maintain homeostasis.
   B. When the two systems work together as one system, referred to as the neuroendocrine system; they perform the same general functions of communication, integration, and control.
   C. In the endocrine system, secreting cells send hormone molecules via the blood to specific target cells contained in target tissues or target organs.
   D. Animation: “Endocrine Glands”*

II. Nervous vs. Endocrine

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<thead>
<tr>
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<th>Nervous System</th>
<th>Endocrine System</th>
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<tbody>
<tr>
<td>Type of transmission</td>
<td>Electrical</td>
<td>Chemical</td>
</tr>
<tr>
<td>Speed of transmission</td>
<td>Fast</td>
<td>Slow (by comparison)</td>
</tr>
<tr>
<td>Route of transmission</td>
<td>Dedicated along nerves</td>
<td>Shared in blood vessels</td>
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<tr>
<td>Length of effect</td>
<td>Short</td>
<td>Longer</td>
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III. Homeostasis
   A. The body’s state of constancy or equilibrium.
   B. Homeostasis is regulated by feedback mechanisms; consists of four parts.
      1. System – the structure or organism effected by stimuli.
      2. Sensor – detects changes in the external or internal environment brought on by stimuli.
      3. Integrator – that which analyzes the change and determines and initiates an appropriate response.
      4. Effector – the structure or organ that implements the response from the integrator.
   C. Types of feedback mechanisms:
      1. Negative feedback:
         a. Most common feedback mechanism.
         b. Safe, inhibitory, and designed to bring the body closer to homeostasis.

* http://www.alegent.com/adam/animationplayer/animation_player.html
c. Ex: Temperature regulation (hot and cold); blood glucose regulation.

2. Positive feedback:
   a. Less common mechanism.
   b. Less safe (even dangerous), excitatory, and designed to take the body away from homeostasis.
   c. Ex: Childbirth; bleeding out.

IV. Glands & Hormones
A. Glands of the endocrine system are widely scattered throughout the body.
B. Endocrine glands are “ductless glands” and highly vascular; these glands secrete their substances directly into the blood.
C. Hormones – chemicals produced and secreted by endocrine glands carried to almost every point in the body; can regulate most cells; effects work more slowly and last longer than those of neurotransmitters.

V. Pituitary Gland
A. Small, pea-sized gland located beneath the hypothalamus in the brain; connected to the hypothalamus by a short stalk called the infundibulum.
B. Referred to as the “master gland” of the body as it controls the other endocrine tissues of the body.
C. Divided into an anterior and posterior lobe, each producing and secreting their own hormones.
D. Animation: “Pituitary Gland”*
E. Anterior pituitary – front portion of the pituitary gland; secretes six separate hormones.
   1. Growth hormone (GH) – controls the growth of bone and soft tissue; increases glycogen synthesis and fat metabolism in the body.
   2. Thyroid-stimulating hormone (TSH) – stimulates the thyroid gland to produce thyroid hormones for the regulation of metabolism.
   3. Adrenocorticotropic hormone (ACTH) – stimulates the growth and development of the adrenal cortex; stimulates the adrenal cortex to produce cortisol.
   4. Prolactin (PRL) – stimulates the production of milk in the mammary glands of the breast; promotes breast development during pregnancy.
   5. Follicle-stimulating hormone (FSH) – stimulates development of the follicle (structure in the ovaries that produces the egg) in the female; stimulates the production of sperm in the male.
   6. Luteinizing hormone (LH) – acts with follicle-stimulating hormone to develop the follicle in the female; promotes ovulation in the female; stimulates the secretion of testosterone from the testes in the male.
F. Posterior pituitary – back portion of the pituitary gland; secretes two separate hormones.

* http://www.alegent.com/adam/animationplayer/animation_player.html
1. Antidiuretic hormone (ADH) – increases water reabsorption in the kidneys to decrease urine formation; also called vasopressin.
2. Oxytocin (OT) – stimulates contraction of the uterus in childbirth and milk letdown from the mammary glands of the breast.

VI. Pineal Gland
A. Located just above the midbrain
B. Involved in regulating the body’s biological clock.
C. Produces melatonin as a “timekeeping hormone.”
   1. Melatonin levels increase when sunlight is absent and decreases when sunlight is present, thus regulating the circadian (daily) biological clock.

VII. Thyroid Gland
A. A bowtie-shaped gland in the neck just below the larynx.
   1. Triiodothyronine and thyroxine (T3 & T4) – increases the metabolic rate and regulates the rate of growth.
   2. Calcitonin – lowers blood calcium levels by inhibiting release of calcium from bone tissue (osteoclasts), and stimulating calcium deposition into bone tissue (osteoblasts).

VIII. Parathyroid Glands
A. Four to five tiny glands embedded in the lobes of the thyroid gland.
   1. Parathyroid hormone (PTH) – increases blood calcium levels by promoting calcium mobilization from bone tissue (osteoclasts) and calcium absorption from the intestines.

IX. Thymus Gland
A. Found in the mediastinum anterior to the heart; location for the maturing of T-cells.
B. This gland is active during fetal development, infancy, and childhood.
   1. Thymosin – hormone secreted to stimulate the new T cells to mature.
C. Gland begins to atrophy at puberty and is replaced by fat and fibrous tissue and is non-functional in adulthood.
D. Functions of the thymus gland are taken over by lymph tissue in the adult.

X. Adrenal Glands
A. Pair of pyramid-shaped glands located on top of each kidney; also called suprarenal glands; divided into the cortex and medulla.
   1. Adrenal cortex – outer portion of the adrenal gland.
      a. Cortisol – released in response to stress; increases blood sugar levels, fatty acid immobilization, and immunosupression.
      b. Aldosterone – helps regulate blood pressure by promoting sodium uptake and potassium secretion by the kidneys.
XI. Pancreas
A. Long gland located just inferior to the stomach; contains specialized islet cells (Islets of Langerhans) for hormone secretion.
   1. Insulin – produced by beta cells; lowers blood sugar levels by promoting glucose uptake by the cells.
   2. Glucagon – produced by alpha cells; increases blood sugar levels by releasing stored glucose from the liver.

XII. Gonads
A. Both male and female glands that produce sex cells (gametes) and sex hormones.
   1. Testes – the male gonads.
      a. Testosterone – regulates the production of sperm cells in the testes and the development of the penis and accessory glands; causes development of male secondary sexual characteristics (e.g. growth of body and facial hair, deepening of the voice, increased muscle and bone density).
   2. Ovaries – the female gonads.
      a. Estrogen – regulates menstrual changes and sex drive; responsible for the development of secondary sexual organs (e.g. mammary glands in breasts, vagina, uterine tubes) and female secondary sexual characteristics (e.g. fat deposition around hips and thighs, growth of breasts).
      b. Progesterone – develops the uterus in preparation for implantation of a fertilized egg; prevents spontaneous abortion of the fetus by preserving the lining of the uterus.

XIII. Other Hormone-Producing Organs
A. Science has shown that all body tissues have some endocrine function.
B. Kidneys – major function involves filtering the blood and producing urine; also produces hormones.
   1. Renin – stimulates an increase in water retention by the body, thus increasing blood pressure.
   2. Erythropoietin – stimulates the production of red blood cells by the red bone marrow.
C. Placenta – an organ responsible for regulating gas, nutrient, waste, and hormonal exchange between mother and fetus during pregnancy.
   1. Human chorionic gonadotropin (HCG) – stimulates the action of luteinizing hormone, growth hormone, and prolactin.
   2. HCG is the hormone detected in the urine by home pregnancy tests.
D. Stomach – a major organ of the digestive system; secretes hormones that stimulate itself (gastrin) the gallbladder (cholecystokinin [CCK]) and pancreas (secretin), promote digestion, and inform the brain when you have eaten enough.
Diseases of the Endocrine System

XIV. Pituitary Disorders

A. Acromegaly – hypersecretion of growth hormone in adults; characterized by disproportional growth; enlargement of the head, jaw, nose, tongue, ears, hands, feet and some internal organs.
   2. Indications/Contraindications: none.

B. Gigantism – rare hypersecretion of growth hormone during childhood; characterized by proportional growth; increased bone thickness and length, and increased soft tissue thickness.
   1. Cause: same as acromegaly.
   2. Indications/Contraindications: none.

C. Dwarfism – deficiency of growth hormone during childhood; leads to decreased bone growth, short stature, hypoglycemia, muscle weakness, and retarded sexual development.
   1. Types:
      b. Primary dwarfism* – proportional growth; rare.
   2. Cause: disturbance or trauma to the hypothalamus or anterior pituitary gland.

D. Diabetes insipidus – characterized by a deficiency of antidiuretic hormone (ADH) from the posterior pituitary gland.
   1. Causes: inflammation or trauma to the hypothalamus or posterior pituitary gland; radiation to the hypothalamus.
   2. Indications/Contraindications: refer to doctor.

XV. Thyroid Disorders

A. Graves disease (hyperthyroidism) – hypersecretion of thyroid hormones; affects 8 to 10 times more women than men, usually between 30 and 50 years of age; leads to increased basal metabolic rate, goiter, weight loss, nervousness, fatigue, insomnia, diarrhea, heat sensitivity, increased sweating, tachycardia, and exophthalmos.
   1. Cause: autoimmune disorder producing antibodies that bind to the thyroid-stimulating hormone (TSH) receptor sites and mimic the action of TSH, causing an increase in production of thyroid hormones.
   2. Indications/Contraindications: refer to doctor; massage is indicated and beneficial if no infection, inflammation, or tumor is present; avoid anterior portion of the neck.

B. Myxedema (adult hypothyroidism) – hyposecretion of thyroid hormones in adults; characterized by fatigue, goiter, slowing of physical and mental

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* http://www.youtube.com/watch?v=_QBy8DFaLR4
activity, swelling around the eyes, cold intolerance, and coarsening of the skin, particularly on the face.

1. Causes: damaged thyroid gland; genetic defect.
2. Indications/Contraindications: same as Graves disease.

C. Cretinism (childhood hypothyroidism) – hyposecretion of thyroid hormones in children; similar characteristics to myxedema, and, depending on the age of onset, variable amounts of retarded bone and brain development.

1. Causes: same as myxedema.
2. Indications/Contraindications: same as myxedema.

D. Goiter – enlargement of the thyroid gland.

1. Cause – iodine deficiency leading to decreased production of thyroid hormones, leading to increased secretion of TSH, leading to thyroid growth.
2. Indications/Contraindications: refer to doctor.

XVI. Pancreas Disorders

A. Diabetes mellitus – a group of disorders involving the pancreas; characterized by defective insulin response and/or utilization.

1. Insulin-dependent diabetes mellitus (IDDM) – also called juvenile-onset diabetes or type 1 diabetes; characterized by a deficiency of insulin production by the pancreas resulting from a reduction in beta cells in the pancreatic islets; onset is usually before the age of 20; accounts for 10 to 20% of total cases of diabetes; hyperglycemia and polyuria (increased urine production) are common signs; treated with daily insulin injections.
   a. Cause: genetic susceptibility along with autoimmunity to beta cells.
   b. Indications/Contraindications: obtain advice and approval of client’s doctor before performing bodywork.

2. Noninsulin-dependent diabetes mellitus (NIDDM) – also called adult-onset diabetes or type 2 diabetes; often seen in obese patients older than 40 years of age; accounts for most cases of diabetes; treated with exercise and diet therapy.
   a. Causes: insulin resistance based on decreased receptor sensitivity on target tissues in the body; reduction of insulin production.
   b. Indications/Contraindications: obtain advice and approval of client’s doctor before performing bodywork.

XVII. Adrenal Gland Disorders

A. Cushing disease – characterized by excessive production of cortisol from the adrenal cortex; leads to obesity, weakness, fatigue, menstrual abnormalities, hypertension, and a rounded “moon face.”

1. Causes: hypersecretion of adrenocorticotropic hormone from the anterior pituitary gland; cortisol-secreting tumor.
2. Indications/Contraindications: because of possible complications (e.g. osteoporosis), all massage should be light and relaxing;
energy techniques may be most effective; obtain approval of client’s doctor before performing bodywork if in doubt.

B. Addison disease – destruction of the adrenal glands leading to decreased production of adrenal hormones; results in muscle weakness, fatigue, hypotension, nausea, decreased tolerance for stress, and “bronzing” of the skin owing to increased production of adrenocorticotropic hormone (when ACTH is broken down by the liver, one byproduct is melanocyte-stimulating hormone [MSH] which activates melanocytes in the skin.)
   1. Causes: autoimmunity against the adrenal gland; bacterial or viral infection; cancer.
   2. Indications/Contraindications: refer to doctor.

Sample Questions
Which of the following regulates the growth, development, and functioning of the reproductive systems in both males and females?
   A. Calcitonin.
   B. Thyroid-stimulating hormone.
   C. Follicle-stimulating hormone and luteinizing hormone.
   D. Prolactin.

Which gland is positioned above the kidney and secretes epinephrine?
   A. Pituitary gland.
   B. Pancreas.
   C. Adrenal gland.
   D. Liver.

Which hormone goes to the collecting duct of the kidney to stimulate the retention of water by the body?
   A. LH.
   B. ADH.
   C. ACTH.
   D. TSH.

Which hormone stimulates the production of milk in the mammary glands of the breast and promotes breast development during pregnancy?
   A. Estrogen.
   B. Prolactin.
   C. Progesterone.
   D. Oxytocin.

If the adrenal cortex is producing too much cortisol because of hypersecretion of adrenocorticotropic hormone, which of the following conditions will develop?
   A. Cushing disease.
   B. A goiter.
   C. Addison disease.
   D. Dwarfism.
What is the state of balance that the body maintains to stay alive?
A. Negative feedback loop.
B. Metabolism.
C. Homeostasis.
D. Thrombosis.

A decrease in blood calcium levels would lead to the secretion of which hormone from which gland?
A. Calcitonin from the thyroid gland.
B. Calcitonin from the parathyroid gland.
C. Parathyroid hormone from the parathyroid gland.
D. Oxytocin from the posterior pituitary gland.

If a diabetic client takes too much insulin and does not eat enough food, the blood sugar will probably:
A. drop too low.
B. go up too high.
C. stay in normal range.
D. none of the above.

The hormone involved in childbirth and breast feeding is:
A. prolactin.
B. oxytocin.
C. secreted by the anterior pituitary.
D. both B and C are correct.