Chapter 18: Endocrine Glands

I. Functions of the Endocrine System

A. List and describe the eight major functions of the endocrine system:

1. ______________________________________________________________
   ______________________________________________________________
   ______________________________________________________________

2. ______________________________________________________________
   ______________________________________________________________
   ______________________________________________________________

3. ______________________________________________________________
   ______________________________________________________________
   ______________________________________________________________

4. ______________________________________________________________
   ______________________________________________________________
   ______________________________________________________________

5. ______________________________________________________________
   ______________________________________________________________
   ______________________________________________________________

6. ______________________________________________________________
   ______________________________________________________________
   ______________________________________________________________

7. ______________________________________________________________
   ______________________________________________________________
   ______________________________________________________________

8. ______________________________________________________________
   ______________________________________________________________
   ______________________________________________________________
II. Pituitary Gland and Hypothalamus

A. Structure of the Pituitary Gland

1. What bony structure is the pituitary associated with? ____________________
2. What is the infundibulum? ________________________________________
3. Posterior Pituitary or Neurohypophysis
   a. It is continuous with the __________________
   b. It develops from an outgrowth in the area of the __________________
   c. The outgrowth forms the __________________
   d. The enlarged distal end of the outgrowth forms the __________________
   e. Secretions from posterior pituitary are properly called ________________
4. Anterior Pituitary or Adenohypophysis
   a. Arises as an outpocketing of the _________________________________
   b. List the three subdivisions of the anterior pituitary:
      1. ______________________________
      2. ______________________________
      3. ______________________________
   c. Does the anterior pituitary also secrete neurohormones? _____________

B. Relationship of the Pituitary to the Brain

1. The hypothalamohypophysial portal system connects what to what? _______
   a. The first capillary network is in ______________________________
   b. The second capillary network is in ______________________________
2. What substances travel in this portal system? ____________________
3. If a neurohormone causes the secretion of an anterior pituitary hormone it is specifically called ______________________________
4. If a neurohormone prevents the secretion of an anterior pituitary hormone it is specifically called ______________________________
5. Hormones produced in the anterior pituitary enter the____________________
   and are carried by ____________________ to their ____________________
6. Refer to Table 18.1 in the text for names and functions of the neurohormones
7. What is the hypothalamohypophysial tract? ___________________________
8. Where are the neurohormones produced? ____________________________
9. Where are the neurohormones stored until released? ___________________
10. What stimulates release of the stored neurohormones? ___________________

III. Hormones of the Pituitary Gland
A. Posterior Pituitary Hormones
1. Antidiuretic Hormone (ADH)
   a. Functionally ADH ________________________________________________
   b. ADH is also called ____________________
      1. What does this name refer to? ________________________________
   c. ADH is synthesized in the ____________________ of the hypothalamus
   d. The primary target tissue for ADH is ______________________________
      1. Where it functionally:
         a. Promotes ______________________________
         b. Reduces ______________________________
   e. Secretion of ADH varies in response to changes in _________________ & __________________
   f. What is an osmoreceptor? _____________________________________
   g. Osmoreceptors connect to _____________________________________
   h. In response to an increase in blood osmolality:
      1. Osmoreceptors send action potentials at a ____________________
      2. The neurosecretory cells respond by ____________________
      3. ADH causes the kidneys to ______________________________
      4. The additional water dilutes blood solutes thus _________________
         blood osmolality
      5. In addition, the increase in blood osmolality may directly ___________ 
         __________________________________________________________
   i. In response to a decrease in blood osmolality:
      1. Frequency of action potentials from osmoreceptors _____________
2. So the neurosecretory cells release ________________ ADH

3. Therefore the kidneys:
   a. Retain ________________ water
   b. Produce ________________ urine

4. Blood osmolality ______________________________
   j. The ADH neurosecretory cells are also influenced by receptors that detect
      changes in ______________________________
   k. Lower than normal blood pressure causes ____________ ADH secretion
   l. Higher than normal blood pressure causes ____________ ADH secretion

2. Oxytocin
   a. Oxytocin is synthesized in the ________________ of the hypothalamus
   b. Functionally oxytocin:
      1. Stimulates ______________________________________________
      2. Also causes ______________________________________________
      3. Responsible for ___________________________________________
   c. Release of oxytocin is stimulated by:
      1. Stretch ________________________________________
      2. Mechanical ________________________________________
      3. Stimulation ________________________________________

B. Anterior Pituitary Hormones
   1. General
      a. Release of hormones from the anterior pituitary is controlled by
         ______________________________________________________
         from the hypothalamus
      b. Chemically the hormones from the anterior pituitary are:
         ______________________________________________________
   c. The anterior pituitary hormones are transported ________________
   d. Anterior pituitary hormones have a half-life measured in ______________
   e. Anterior pituitary hormones bind to ________________ receptors

2. Growth Hormone (GH)
   a. Is also known as ______________________________
   b. Functionally growth hormone:
1. Stimulates ______________________________
2. Plays ________________________________
3. Regulator ______________________________
4. Increases ______________________________
5. Favors ________________________________
6. Also increases __________________________
7. Increases glycogen ______________________
8. Plays a role in regulating ________________________

   c. What are somatomedins? ________________________________

   d. Functionally somatomedins:
      1. Stimulate growth in ____________________ & __________
      2. Increase _______________________________ muscles

   e. When growth hormone binds to membrane-bound receptors they cause __________________________ inside the cell

   f. Secretion of growth hormone is regulated by two neurohormones from the hypothalamus called:
      1. __________________________
      2. __________________________ or __________________________

   g. What body conditions act on the hypothalamus to:
      1. Increase GH secretion ______________________________
      2. Decrease GH secretion ______________________________

   h. Highest levels of GH are usually associated with ______________________

3. Thyroid Stimulating Hormone (TSH)
   a. Is also known as ______________________________
   b. TSH stimulates ________________________________
   c. TSH also increases the activity of ______________________________
   d. Functionally phospholipase __________________________
   e. TRH from the hypothalamus _______________________ TSH secretion
   f. Thyroid hormones ___________________________ TRH and TSH secretion
   g. TSH levels are normally highest ______________________
4. Adrenocorticotropic Hormone (ACTH) and Related Substances
   a. The precursor molecule is called ______________________________
   b. ACTH
      1. Functionally ACTH increases _________________________ primarily
         __________________________ from ______________________
      2. ACTH also binds to ____________________ & __________________
   c. Lipotropins attach to membrane-bound receptors on _________________
      1. This results in ____________________ & ______________________
   d. β endorphins have the same effects as __________________________
      1. They can play a role in ______________________________
      2. Secretion increases in response to __________________________
   e. Melanocyte-stimulating hormone (MSH)
      1. Binds to receptors on _________________ and stimulates
         __________________________________________________________________

5. Luteinizing Hormone (LH), Follicle Stimulating Hormone (FSH) and Prolactin
   a. Hormones that stimulate growth and function of the gonads are called:
      ______________________________
   b. LH and FSH stimulate the production of:
      1. Gametes:
         a. Males: ____________________ in the ____________________
         b. Females: ____________________ in ____________________
      c. LH and FSH control the production of:
         1. Reproductive hormones:
            a. Females: _______________ & _______________ in the __________
            b. Males: ____________________ in the ____________________
         d. Release of LH and FSH is stimulated by the hypothalamic-releasing
            hormone __________________________________________________
         e. Prolactin plays an important role in ______________________________
         f. Prolactin also increases the number of receptors for ________________
            in the __________________
         g. After ovulation prolactin can ________________________________
IV. Thyroid Gland

A. Structure and Histology
1. The thyroid gland is composed of ____________ lobes connected by an ____________ called ____________
2. The two lobes lie on either side of the __________________________
3. Anatomically the thyroid gland is just inferior to the __________________________
4. Why does it appear redder than surrounding tissue? __________________
5. What is a follicle? __________________________
6. A follicle is composed of a single __________________________
7. Where is thyroglobulin found? __________________________
8. Thyroglobulin is a ____________ to which __________________ is bound
9. Where are parafollicular cells found? __________________________
10. What is produced by the parafollicular cells? __________________________
    a. This hormone plays a role in __________________________

B. Thyroid Hormones
1. The two forms of thyroid hormone are:
   a. __________________________
   b. __________________________ also called __________________________
2. Thyroid Hormone Synthesis
   a. Which hormone from the anterior pituitary is required for synthesis of thyroid hormones? __________________________
   b. Synthesis of thyroid hormones also requires ____________ in the diet
   c. The synthesis and secretion of thyroid hormone involves:
      1. Iodide ions are taken up by ____________ by ____________
      2. Follicle cells synthesize the protein __________________________
         a. This protein contains numerous ____________ amino acids
      3. One or two iodine atoms are bound to each __________________________
a. Thyroglobulin enters the lumen of the follicle by _______________

4. In the lumen of the follicle:
   a. T₄ is formed by ____________________________
   b. T₃ is formed by ____________________________

5. Thyroglobulin enters follicle cells by _______________
   a. What fuses with the vesicle? ____________________________

6. __________ enzymes (from the lysosomes) break down thyroglobulin
   a. When __________ & __________ are released they move by ____________________________ into the ____________________________ & finally ____________________________

3. Transport in the Blood
   a. Thyroid hormones are transported in the circulatory system with
      1. 70-75% bound to ____________________________
      2. 20-30% bound to ____________________________ including __________
   b. Thyroid hormone bound to proteins increases ____________________________
   c. Approximately 33-40% of __________ is converted to __________
      1. Which form is the major hormone? __________
      2. Which form is more potent? __________

4. Mechanism of Action of Thyroid Hormones
   a. Thyroid hormones interact with receptors ____________________________
   b. After binding to the receptor the hormone causes ____________________________
   c. The newly made ____________________________ moves to the ____________________________
   d. In the cytoplasm new ____________________________ are made
   e. The newly synthesized __________ cause the ____________________________
   f. This process can take up to a _________ for maximal effect

5. Effects of Thyroid Hormones
   a. Thyroid hormones affect ____________________________
      1. ____________________________ is primarily affected in some tissues
      2. __________ & ____________________________ are influenced in others
   b. Functions of thyroid hormones include:
      1. Normal rate ____________________________
2. Decline in ______________________________
3. Increased activity of ______________________________
4. Alter the number and ______________________________
5. Normal ______ and ____________________ of organs
6. Normal ______ and ____________________ of the brain
7. Permissive role for ________________________

c. What symptoms might a person experience with thyroid hormone:
   1. Hypersecretion __________________________________________
      _______________________________________________________
   2. Hyposecretion __________________________________________
      _______________________________________________________

d. If hyposecretion occurs during development a person experiences:
   1. Decreased ________________________________________
   2. Abnormal nervous ____________________________________
   3. Abnormal ____________________
   4. Abnormal ____________________ of tissues
      a. The result is a mentally ____________________ with ________
         stature and distinctive form called a ____________________

6. Regulation of Thyroid Hormone Secretion
   a. TRH from the hypothalamus and TSH from the anterior pituitary:
      1. Increase in response to _________________________________
      2. Decrease in response to _________________________________
   b. TSH stimulates ____________________ secretion from the thyroid gland
      1. TSH also stimulates _________________________________
   c. Thyroid hormones have a ____________________ effect
      1. Increasing levels ____________________ TRH & TSH release
   d. TSH levels in the blood increase dramatically when __________________
      _______________________________________________________

C. Calcitonin
   1. Calcitonin secretion is increased in response to ____________________
      _______________________________________________________

2. The primary target tissue for calcitonin is ____________________
   a. Decreases ______________________________
   b. Lengthens ______________________________

3. The net result of calcitonin action is a ____________________ in blood levels of ____________________ and ____________________

4. How important is calcitonin in regulating blood calcium levels? ____________
   a. After a meal it may ___________________________________________
   b. How do calcitonin levels change with age? _________________________
   c. Complete thyroidectomy ______________________________________

V. Parathyroid Glands

A. Parathyroid glands are usually embedded ______________________________

B. Parathyroid Hormone (PTH)
   1. PTH is important in the regulation of ______________________________
   2. Functionally PTH:
      a. Stimulates ______________________________ in bone
      b. Can cause ______________________________ to increase
      c. Induces ______________________________ within kidneys
      d. Also increases ______________________________ in the kidneys
   3. In relation to phosphate ions PTH
      a. ____________________ from bone
      b. ____________________ absorption in the gut
      c. ____________________ in the kidney
   4. The net effect of PTH is to:
      a. ____________________ blood levels of calcium ions
      b. ____________________ blood levels of phosphate ions
   5. The release of PTH is:
      a. Stimulated by ______________________________
      b. Inhibited by ______________________________
   6. Symptoms of hypocalcemia include: ________________________________
      ________________________________
VI. Adrenal Glands

A. Structure and Histology
   1. The adrenal glands are also called ______________________________
   2. What is their position relative to the kidneys? _________________________
   3. What does retroperitoneal mean? _________________________________
   4. Composed of an inner _______________ and an outer _______________
      a. The inner portion arises from ___________________________________
      b. The outer portion is derived from ________________________________
   5. The medulla consists of __________________________________________
   6. The cortex is composed of ____________________ and subdivided into:
      a. ______________________________
      b. ______________________________
      c. ______________________________
   7. The zona glomerulosa is:
      a. Immediately ______________________________
      b. Composed of ______________________________
   8. The zona fasciculata is the __________ part of the adrenal cortex:
      a. The cells form ____________________ or ____________________
   9. The zona reticularis is the __________ layer of the adrenal cortex:
      a. Thin ____________________
      b. Irregularly ____________________

B. Hormones of Adrenal Medulla
   1. The adrenal medulla produces about:
      a. 80% ______________________________
      b. 20% ______________________________
      1. Why are these secretions considered to be neurohormones? _______
   2. Functionally epinephrine:
      a. Increases blood ______________________________
      b. In skeletal muscle cells ______________________________
c. In adipose tissue ________________________________
d. Cause dilation of blood vessels in ________________________________

3. Epinephrine and norepinephrine function to:
   a. Increase the heart's _______ & ______________________________
   b. Cause vessel constriction to ________________________________

4. The effects of epinephrine and norepinephrine are _____________________

5. The release of hormones by the adrenal medulla is stimulated by:
   ______________________________________________________________

6. Conditions resulting in release include: ______________________________
   ______________________________________________________________

C. Hormones of Adrenal Cortex

1. Steroid hormones that are highly ______________ derived from __________
2. They leave the cells as soon as they are produced by ___________________
3. They are transported in the blood in combination with ___________________
4. They bind to ________________ receptors and stimulate synthesis of
   ______________________________ which are responsible for __________

5. Mineralocorticoids are produced in the ______________________________
   a. ____________________ is produced in the greatest amount
   b. Functionally aldosterone:
      1. Increases the rate of ___________________________ by the kidneys
         a. As a result blood levels __________________
      2. Increases K⁺ _____________________________ by the kidneys
         a. As a result blood levels __________________
      3. Also increases the rate of __________ excretion into the urine

6. Glucocorticoids are produced in the ______________________________
   a. The major glucocorticoid is ______________________________
   b. The responses are classified into three categories:
      1. ______________________________
      2. ______________________________
      3. ______________________________
c. Metabolic responses include:
   1. ____________________ fat catabolism
   2. ________________ glucose and amino acid uptake in skeletal muscle
   3. ____________________ gluconeogenesis
      a. What is gluconeogenesis? ________________________________
   4. ____________________ protein degradation
d. Developmental responses include:
   1. Maturation of ________________________________________
   2. Development of ________________________________________
e. Anti-inflammatory responses include decreasing both the number of ____________________________ & ____________________________
f. Control of secretion involves:
   1. CRH from the hypothalamus released in response to ___________ or _______________
   2. CRH stimulates the release of ACTH from the ___________________
   3. ACTH stimulates the:
      a. Zona glomerulosa to ______________________________
      b. Zona fasciculata to ______________________________
   4. CRH release is inhibited by __________ & ______________
   5. High levels of cortisol ____________________ ACTH release
   6. Low levels of cortisol ____________________ ACTH release
   
7. Adrenal Androgens
   a. Produced in the ______________________________
   b. Weak androgens including ______________________________
   c. Converted by peripheral tissues to ______________________________
   d. Functionally in females adrenal androgens:
      1. Stimulate __________ & __________ hair growth and _____________
   e. Functionally in males their effects are ______________________________
VII. Pancreas

A. Structure and Histology
1. The pancreas lies ____________________ between the ________________
   ____________________ and the ____________________
2. Exocrine portion consists of ______________ that produce ______________
   secreted into a __________ system that empties ______________________
3. Endocrine portion consists of ____________________ that produce
   ____________________ that enter the ____________________
4. Each pancreatic islet is composed of:
   a. 20% ____________________ that secrete ____________________
   b. 75% ____________________ that secrete ____________________
   c. 5% ____________________ including ____________________ that
       secrete ____________________
5. The pancreatic islets have "dual innervation" which means _______________
   _______________________________ (see Chapter 16 if needed for review)

B. Effect of Insulin and Glucagon on Their Target Tissues
1. The main insulin target tissues include _______________________________
   ________________________________________________________________
2. Insulin causes an increase in active-transport proteins for ________________
   and ____________________
3. As a result the general response is an ____________________ in the ability
   to take up and use ____________________ and ____________________
4. Even though blood levels of glucose are very high in the absence of insulin
   the ability of the cell to take in glucose and amino acids _________________
5. In contrast high levels of insulin can cause blood levels of glucose to _______
   because target tissues are ______________________________
   a. This can cause malfunctions of the ______________________________
6. Glucagon primarily effects the __________ but has some effect on ________
   ____________________ & ____________________
7. Functionally glucagon causes:
   a. Breakdown of ____________________
C. Regulation of Pancreatic Hormone Secretion

1. Beta cells are directly influenced to:
   a. Release insulin in response to ______________________________
   b. Inhibit insulin release in response to __________________________
   c. Certain amino acids _________________________________________

2. The autonomic nervous system influences insulin secretion:
   a. Parasympathetic nerve impulses ______________________________
   b. Sympathetic nerve impulses _________________________________

3. What hormones from the gastrointestinal tract stimulate insulin release? ________________________________

4. What effect does somatostatin have on insulin and glucagon? ______________

5. Secretion of glucagon is:
   a. ______________________ by low blood glucose levels
   b. ______________________ by high blood glucose levels

6. Glucagon secretion is also increased by ______________ & ______________

7. After a high-protein meal:
   a. Amino acids increase ______________ & _______________ secretion
   b. Insulin causes _____________________________________________
   c. Glucagon increases _________________________________________

VIII. Hormonal Regulation of Nutrients

A. After a meal and under resting conditions:

1. There is reduced secretion of __________, __________, __________, & ________________

2. Insulin secretion increases in response to:
   a. ______________________________
   b. ______________________________

3. This causes target tissues to increase their uptake of __________, __________, and __________.
4. Molecules not needed for immediate metabolism are ________________
   a. Glucose is converted to __________ in ______________ & __________
   b. Glucose is used for __________ synthesis in __________ & __________

5. The rapid uptake and storage of __________ prevents ________________

6. Amino acids are _______________________________.

7. Ingested fats are ______________________________________

B. Within 1-2 hours after the meal:
   1. Absorption of digested material __________ and blood glucose levels ______
   2. This causes increased secretion of __________, __________, __________, & __________
   3. Results in release of ________________ from tissues
   4. Insulin secretion ____________ & glucose uptake by cells ______________
   5. Stored glycogen is converted to __________ and released into __________
   6. This maintains blood glucose levels necessary for ________________
   7. Cells using less glucose start using more __________ & __________
   8. Adipose tissue ________________ & the liver releases __________

C. During exercise:
   1. Sympathetic nerve impulses stimulates release of ________________
      from the adrenal gland and ________________ from the pancreas
   2. These hormones induce the conversion of __________ to __________
      in the liver and the ________________
   3. During sustained activity blood glucose levels may fall too low for normal
      ______________________________
      a. A decrease in insulin prevents ______________________________
      b. Fatty acids, triglycerides, and ketones increase in the blood due to
         increased levels of __________, __________, __________, & __________
      c. GH also prevents muscles from using themselves as an energy source by
         ______________________________
      d. Therefore, in skeletal muscles the metabolism of:
         a. Glucose ____________________
         b. Fat ____________________
IX. Hormones of the Reproductive System

A. Male Hormones
1. Main endocrine glands of the male reproductive system are the __________
2. Their function depends on __________________ from the anterior pituitary
3. Functionally testosterone regulates:
   a. Production of _____________________________
   b. Development and ___________________________
4. Inhibin functions to _____________________________
5. Which is the main hormone secreted by the testes? __________________

B. Female Hormones
1. Main endocrine glands of the female reproductive system are the _________
2. Their function depends on __________________ from the anterior pituitary
3. The main hormones secreted by the ovaries are _________ & _________
4. Functionally these hormones with FSH and LH control:
   a. Female ______________________________
   b. Prepare ______________________________
   c. Maintain ______________________________
5. Estrogen and progesterone are responsible for development of __________
   __________________________ and female __________________________
6. The ovaries also secrete __________ which inhibits __________ secretion
7. During pregnancy both the ___________ and ___________ secrete
   __________________________ and __________________________
8. What is the function of the hormone relaxin? __________________________
   ____________________________________________________________________

X. Hormones of the Pineal Body

A. List the two hormones secreted by the pineal body:
1. ______________________________
2. ______________________________

B. Functions
1. Melatonin can decrease __________ secretion from the ________________
a. May inhibit ______________________________________

2. Melatonin may also help regulate ___________________________________

C. Control of Secretion

1. What is photoperiod? ________________________________

2. Increased daylight results in ___________________ pineal secretions
   a. Therefore in the spring when the days get longer there will be less ______________ of reproductive function

3. Decreased daylight results in ___________________ pineal secretions
   a. Therefore in the fall and winter reproductive function is ______________

D. The exact function of pineal body hormones in humans is ______________

XI. Hormones of the Thymus

A. The thymus is located in the neck _____________________ to the heart

B. It secretes the hormone _______________________

C. The thymus and its hormone play a role in ______________________________
   ________________________________

XII. Hormonelike Substances

A. Prostaglandins

1. Prostaglandins are involved in a wide range of activities including:
   a. Regulation of ________________________________
   b. Process of _________________________________
   c. Inhibition of ________________________________ luteum
   d. ______________________________ function
   e. Modification of the _________________________________
   f. Pain receptors are ______________________________
   g. Cause ______________________ of blood vessels

2. Anti-inflammatory drugs ______________________________

B. Substances that moderate the sensation of pain include:

1. ______________________________
2. ______________________________
3. ______________________________

C. Growth Factors
   1. Epidermal growth factor ______________________________
   2. Interleukin-2 stimulates ______________________________

XIII. Effects of Aging on the Endocrine System
   A. With increased age:
      1. Secretion levels of GH __________________________
         a. There is a greater change in people who ______________________
         b. Change in GH secretion may explain _______________________
      2. Secretion levels of thyroid hormones ________________________
         a. Thyroid gland may also be damaged by ______________________
      3. Parathyroid hormone secretion ______________________________
      4. Reproductive hormone secretion ______________________________
      5. The ability to regulate blood glucose levels ___________________
      6. The immune system becomes less effective because _____________