INTRODUCTION TO THE ENDOCRINE SYSTEM

Text Reference: Chapter 18.

I. Endocrine system and nervous system (refer to Chpt. 18).
   A. Discuss the concept of the “neuroendocrine” system
   B. Compare and contrast the nervous and endocrine systems. Complete the list/comparison below (Refer to Chpt. 18 Table 18.1, p. 587)

   **Nervous System …………..vs. …………..Endocrine System**

<table>
<thead>
<tr>
<th>Neurotransmitter</th>
<th>Blood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid rate of response</td>
<td>Longer lasting effect</td>
</tr>
<tr>
<td></td>
<td>Target cells w/receptors</td>
</tr>
</tbody>
</table>

II. Endocrine gland vs. Exocrine gland.
   A. Compare/Contrast the two. You may want to use a similar format given above for nervous vs. endocrine.

   B. The pancreas may be considered both an endocrine and an exocrine gland. Explain. (Refer Fig. 18.18.)

   C. Location of Endocrine Glands: Identify and give the location of various endocrine glands of the body. *(Copy Fig. 18.1 prior to lecture/class)*

   D. What are some general functions of hormones? See Figure 18.1.

III. Hormone Activity
   A. Discuss how a hormone functions and include the following terms:
      1. Target cells
      2. Receptors
      3. Down regulation and effect on target cell
      4. Up regulation

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B. Blocking Hormone Receptors—a clinical application/example
   1. Clinical implications of RU486 (mifepristone)

   2. Think about other factors that may interfere with functioning of hormone receptors.

E. Circulating and Local Hormones (Fig. 18.2)
   1. Endocrines
   2. Local hormones
      a. Paracrines
      b. Autocrines
   3. Compare longevity of each
   4. Give examples

F. List and describe the 3 Functions of transport proteins
   1. Improve transportability of lipid soluble hormones by making them
      2. Retard filtering mechanism of small hormones in kidney, therefore they
      3. Provide backup supply of hormones in the

G. What hormones do:
   1. Stimulate synthesis of new molecules
   2. Change permeability of cell membrane
   3. Stimulate transport of products into or out of cell
   4. Alter rate of metabolic processes
   5. Stimulate contraction of smooth or cardiac muscle

H. Chemical Classes of Hormones & Their Mechanisms of Actions
   1. Lipid–soluble hormones: Copy and study Fig. 18.3 then outline the mechanism of action of a lipid-soluble hormone. Answer the following questions:
      a. What is the relationship between the free fraction of the hormone and the transport proteins?
      b. Where is the receptor of a lipid-soluble hormone located?
      c. What does it mean that the cell must be a target cell?
      d. What does it mean that a cell must first recognize the hormone or that the hormone must “announce its arrival” to the cell?
      e. How does a hormone alter “gene expression” of DNA?
      f. Explain: The enzyme produced as a result of hormonal stimulation causes the cell’s response to that hormone.
2. Water soluble hormones: Copy and study Fig. 18.4 then outline the mechanism of action of a water-soluble hormone. Answer the following questions: This will involve careful reading and study.
   a. Compare water-soluble hormones to lipid-soluble hormones.
   b. How does the water-soluble hormone get from the blood to the cell’s receptor?
   c. Where is the receptor of the water-soluble hormone located?
   d. Is the receptor an integral or peripheral protein? What does this mean?
   e. The hormone is considered, in this example, a “first messenger.” What does this mean?
   f. What is the role of the G protein?
   g. What is the role of the enzyme adenylate cyclase and where does this occur?
   h. cAMP is considered the “second messenger.” Explain.
   i. What does cAMP activate?
   j. A protein kinase is an enzyme that phosphorylates cellular proteins. What does this mean? (Note: Many of these cellular proteins are enzymes such as enzyme 1 and enzyme 2 illustrated in Fig. 18.4).
   k. What role does ATP play in this picture?
   l. Enzymes activated by phosphorylation catalyze certain cellular reactions resulting in a variety of physiologic responses. Explain this statement and give examples.
   m. As cAMP increases we will see an increase in phosphodiesterase. What role does phosphodiesterase play? Describe this mechanism in terms of a negative feedback mechanism.
   n. cAMP is a common “second messenger.” Calcium and other substances may act as second messengers as well. A given hormone (or even a neurotransmitter) may use different second messengers in different target cells. Do you understand these statements?
   o. Hormones that bind to plasma membrane receptors may function at very low concentrations. This is because they stimulate a cascade of responses. Explain this statement.
   p. Use epinephrine as an example for the preceding statement (o), explain how a single molecule of epinephrine can result in the breakdown of millions of glycogen molecules into glucose (glycogenolysis).

I. Clinical Consideration: The toxin produced by cholera bacteria causes the G proteins in intestinal epithelial cells to be locked in an activated state. As a result, the cAMP level skyrockets. How does this result in massive watery diarrhea and potential death to the victim? What are the two critical medical treatments?
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J. Hormone Interactions
1. The responsiveness of a target cell to a hormone depends on:
   a. concentration of the hormone
   b. number of receptors on the target cells
   c. influences by other hormones

2. Describe the following terms and relate them to the hormone interactions described above.
   a. Permissive effect
   b. Synergistic effect
   c. Antagonistic effect

K. Glucose regulation through the hormones insulin and glucagon is an example of a pair of hormones that have a/an __________ effect. What does each do to the level of glucose? We’ll look at this in more detail on the next handout and in increasingly greater detail as we progress through these two semesters (so learn it well now and at each subsequent exposure!!!!)

IV. Control of hormone secretion.
A. Regulation of hormonal secretion is a very important mechanism for maintaining homeostasis of many body conditions.

B. Regulation of hormonal levels is very precise and is usually maintained within very narrow margins/limits.

C. Hormone secretion is regulated by
   1. signals from the
   2. chemical changes in the
   3. other

D. Under normal, homeostatic physiologic conditions, hormone levels are not over produced or under produced, although their levels may increase/decrease to meet the physiological needs of the body.

E. Disorders (homeostatic imbalances) often involve hyposecretion (__________ secretion) or hypersecretion (__________ secretion) of hormones resulting in certain physiologic conditions being out of balance (out of control). Sometimes the level of secretion is not the problem, but the problem may involve faulty hormone _________ or insufficient numbers of receptors. These conditions may be the basis for a disease or disorder such as diabetes mellitus (We’ll be looking at this in a lot of detail very soon).

F. Most hormones are regulated through ___________ feedback systems.

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G. Sometimes, a normal physiologic condition is regulated through a __________ feedback system (remember oxytocin), but more frequently a positive feedback system results in a disease or a disorder.

V. Hypothalamus and Pituitary Gland
   A. Study Fig. 18.5 and note the physical/structural relationship between the hypothalamus, infundibulum, and the pituitary gland.
   B. What is the structural/physical relationship between the anterior pituitary gland and the posterior pituitary gland?
   C. Describe the structural and functional relationship between the hypothalamus and the posterior pituitary gland. Include “neurosecretory cells” in your answer.
   D. What are the two hormones produced by the neurosecretory cells of the hypothalamus that are then carried to the posterior pituitary where they are stored and then released into the blood?
   E. Explain why the hypothalamus is now considered an endocrine gland.
   F. Describe the structural/functional relationship between the hypothalamus, hypophyseal portal system, and the anterior pituitary gland. Include releasing and inhibitory hormones (regulatory hormones) in your answer.
   G. The anterior pituitary produces many, many hormones that regulate other endocrine activities and many body functions. (For reference: see Table 18.3. You do NOT have to list them or know them right now—you'll learn them gradually as we progress through the systems). For that reason, the anterior pituitary used to be called the “master gland.” It no longer is considered the master gland. The hypothalamus is now considered the master gland. Why?

VI. Regulation of glucose through the hormones insulin and glucagon is a very good example of hormone regulation through a negative feedback mechanism. It is an extremely important concept that you will be using continually throughout these two semesters (so learn it well, in detail NOW!!!).

   A. Review Fig. 18.18. Remember the pancreas is both an endocrine gland and an exocrine gland. For this concept, we will be considering the endocrine aspects of the pancreas.
      1. Islets of Langerhans (pancreatic islets)
      2. Alpha cells
      3. Beta cells

   B. Diagram and explain the regulation of glucose by insulin and glucagon as an example of a negative feedback mechanism (see Fig. 18.19 and read associated text).

   C. What other factors influences the release or inhibition of insulin and glucagon?

   D. List and describe the functions of the hormones insulin and glucagon (see Table 18.9)
E. Relate glucose regulation to the “G words” and other related words (you may have learned these in a previous biology class—if not, look these up in your text (glossary and Chpt. 25) and listen in class for their descriptions within this context. You can understand why spelling of these words must be perfectly accurate.
1. glucose
2. glycogen
3. glucagon
4. glycogenesis
5. glycogenolysis
6. gluconeogenesis
7. glycolysis
8. hypoglycemia
9. hyperglycemia
10. insulin

Some review questions:
- The pancreas is considered both an exocrine and an endocrine gland. Explain.
- Which pancreatic cells (specifically) are responsible for glucagon secretion? For insulin secretion?
- If you haven’t eaten for a long while, which hormone is most active?
- If you just ate a huge carbohydrate meal, which hormone is most active?
- This is an example of how two hormones work together to regulate a “controlled condition” in the body and yet they work in opposition to each other. Explain.

F. We’ll continue studying this and we’ll tie it all together when we study cellular respiration, cellular metabolism and the absorptive and postabsorptive states (Chpt. 25).

VI. Clinical Application: Diabetes Mellitus
A. Describe diabetes mellitus.
B. Describe and compare/contrast Type I diabetes mellitus (IDDM, juvenile onset diabetes mellitus) and Type II diabetes mellitus (NIDDM). How do these compare with gestational diabetes?
C. What are the three polys?
1. Polyuria
2. Polydipsia
3. Polyphagia
D. Relate this to ketoacidosis (more with metabolism)
E. Describe hypoglycemia—the physiologic condition and the clinical symptoms.
F. What is hyperinsulinism and insulin shock?
G. How does stem cell research offer hope for Type I diabetics?
H. See Lecture Syllabus page 5 for 2 assignments and Bonus Assignment associated with the endocrine system.