

SYLLABUS

COURSE: DENF 1541 Physiology I
SEMESTER: Fall
CREDIT HOUR: 3.0

REVISED: 2009
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COURSE DIRECTOR: Norman Weisbrodt, Ph.D.

GOAL

The goal of this course is to provide the dental student with the basic concepts and principles of physiology with particular emphasis given to those areas that are of prime concern to the dental practitioner. The ultimate goal of the dental practitioner is to correctly diagnose and treat diseases of the oral cavity. The concepts learned in physiology provide the student with the basis for the interpretation of symptoms associated with certain disease states, and with knowledge for the appropriate treatment of those disease states.

OBJECTIVES

I. EXCITATORY TISSUES

A. Introduction

1. Describe the relationship between the structure of a cell membrane and the movements of substances in and out of the cell.
2. Describe the principles behind the development of the membrane potential.
3. Describe the characteristics of the electrical potentials generated across cell membranes.
 - 3.1 resting membrane potential
 - 3.2 responses to stimulation
 - i. hypopolarization
 - ii. depolarization
 - iii. hyperpolarization
4. Describe the typical neuron.
 - 4.1 List the structural features of the neuron.
 - 4.2 List the types of neurons and describe their roles in the nervous system.
5. Describe how a neuron transmits information.
6. Describe how anatomical and local environmental factors affect the transmission of this information.
7. Describe the ways in which neurons can interact, and the role of neurotransmitter in these interactions.

B. Muscle

1. List the three types of muscle tissues, and describe the characteristics of each.
2. Describe the chemical and mechanical steps in the crossbridge cycle and explain how the crossbridge cycle results in shortening of the muscle.
 - 2.1 Relate this process to changes observed in the sarcomere.
 - 2.2 Describe any differences among the three types of muscle.
 - 2.3 Describe the role of ATP in the cycling process.
3. Describe the structure of a neuromuscular junction in skeletal muscle, and compare it to the nerve-muscle connections found in smooth and cardiac muscle.
4. Describe the sequence of events involved in neuromuscular transmission in skeletal muscle.
 - 4.1. Distinguish between endplate potential and action potential in skeletal muscle.

- 4.2 Compare a skeletal muscle action potential to the action potentials produced by neurons.
 - 4.3. Compare and contrast the action potentials of skeletal, cardiac and smooth muscle.
5. Describe the steps involved in excitation-contraction coupling in skeletal muscle, and describe the roles of the:
 - 5.1. sarcolemma
 - 5.2. T-Tubules
 - 5.3. sarcoplasmic reticulum
 - 5.4. calcium ions
 - 5.5. calsequestrin
 - 5.6. the calcium pump
 - 6 Compare the regulatory systems of skeletal muscle and smooth muscle, and give characteristic of each.
 - 6.1 Describe the cellular pathways involved in excitation-contraction coupling in smooth muscle, compare them to those of skeletal muscle.
 - 6.2. Describe the mechanisms that control contraction and relaxation in smooth muscle.
 - 6.3. Describe the role of calmodulin as a regulatory protein in smooth muscle.
 7. For cardiac muscle, describe the means and sites of calcium entry, its storage and the role that these processes play in the excitation-contraction coupling. Compare these events to those of skeletal and smooth muscle.
 8. Distinguish between a twitch, treppe and tetanus in skeletal muscle. Based on the characteristics of its action potential describe why tetanus does not occur in cardiac muscle.
 9. Describe the length-tension relationship in skeletal muscle.
 - 9.1 Relate this relationship to the sliding filament process.
 - 9.2 Compare this relationship in skeletal muscle to that seen in smooth and cardiac muscle
 - 9.3 Relate the operating length of muscle to the length tension relationship.
 10. Describe the conditions necessary to produce an isometric and an isotonic contraction in skeletal muscle.
 11. Describe the energy sources used for muscle contraction. Indicate the role of myoglobin and lactic acid in maintaining the energy supply of skeletal muscle. Differentiate between the metabolic types of skeletal muscle.
- C. Autonomic Nervous System
1. Discuss the role played by the Autonomic Nervous System (ANS) in homeostasis. Describe how the ANS interacts with other control systems of the body to accomplish this task.
 2. Identify the two divisions of the ANS.

3. Identify by name the preganglionic and postganglionic neurotransmitters and receptors for the
 - 3.1 Sympathetic Division of the ANS (SANS).
 - 3.2 Parasympathetic Division of the ANS (PSANS).
 - 3.3 Name the exceptions.
4. Compare the innervation of involuntary organs to that of voluntary organs, in terms of anatomy and neurochemistry.
5. Describe the ability of the sympathetic division to activate multiple effectors at one time. Contrast its activity to that of the parasympathetic division.
6. Compare the role of agonist and antagonists to that of the neurotransmitters.
7. Describe the opposing actions of the parasympathetic and sympathetic divisions on organs and organ systems, and describe the role of the central nervous system in coordinating the two opposing influences.
8. Describe the role of the adrenal cortex and adrenal medulla in supporting the functions of the ANS.

II. GASTROINTESTINAL SYSTEM

1. Describe the general function of the digestive system.
2. Describe the role of the oral cavity in the digestion of food.
3. Describe the swallowing process.
4. Describe the role of the esophagus in digestion and the controls its activity. As part, of the description include:
 - 4.1 A description of peristalsis.
 - 4.2 A description of the roles of the submucosal and myenteric plexi in controlling the activity of the gut.
 - 4.3 A description of the role of the autonomic nervous system.
5. Describe the role of the stomach in digestion and the control its activity. In your description:
 - 5.1 Describe the role of sphincter muscles.
 - 5.2 Describe and contrast the mixing activities to the propulsive activities of the stomach.
 - 5.3 Identify and describe the secretion of the stomach.
 - 5.4 Describe the mechanisms controlling each of these activities.
 - 5.5 Identify the absorption occurring in the stomach.
6. Describe the roles of the following accessory structures in the function digestion. Include a description of the mechanisms that control their activities.
 - 6.1 liver and gall bladder
 - 6.2 pancreas

7. Describe the role of the small intestines in digestion and the control of its activity.
 - 7.1 For each of the major nutrients, carbohydrates, proteins and fats discuss the following.
 - i. The dietary form of the nutrient.
 - ii. The enzymes and additional factors that participate in the digestion process.
 - iii. The end products of the digestion process.
 - iv. The sites of its digestion.
 - 7.2 For each of the major nutrients, describe the site and transport process used for its absorption.
 - 7.3 Describe the absorption of water and major electrolytes.
8. Describe the role of the colon in digestion, absorption and storage and the control of these activities.
9. Describe the role of the gut's bacterial flora.
10. Describe the activities of the rectum and the mechanisms that control them.

III. ENDOCRINOLOGY

A. Introduction to Endocrinology

1. Define homeostasis.
2. Describe and contrast the roles of the endocrine and nervous systems in homeostasis.
3. Identify the chemical nature of each hormone covered in this course, and indicate the therapeutic significance of knowing the chemistry.
4. Describe the negative feedback mechanism by which hormone levels are regulated. Describe the specifics of this mechanism for all hormones to be covered in this course.
5. Describe diurnal and episodic secretions and indicate what group of hormones demonstrates these types of secretion.
6. Describe the transport of hormones in the blood. The description should include identifying the types of hormones which are bound to plasma proteins and the effects of binding on the hormone's activity and its duration.
7. Describe and contrast the two basic mechanisms of hormone action. The description should include the steps involved in each of the two mechanisms and identifying which mechanism is used by each of the hormones covered in this course.

B. Pituitary Gland

1. List the major hormones of the adenohypophysis and neurohypophysis by name and abbreviation.

2. Describe the basic anatomical and functional relationships between the anterior pituitary and the hypothalamus, and posterior pituitary and the hypothalamus.
 3. List the major releasing and inhibitory factors of the hypothalamus by name and abbreviation.
 4. Describe the regulation of the hypothalamus.
 5. Identify the posterior pituitary hormones, and describe their functions and regulation.
- C. Male Reproductive Endocrinology
1. Describe the factors involved in sexual differentiation. Include the role of genetics and hormone regulation.
 2. Describe spermatogenesis and describe the factors that regulate it.
 3. Describe the regulation and functions of the androgens (testosterone).
- D. Female Reproductive Endocrinology
1. Describe the events in a normal ovarian cycle. The description should include:
 - 1.1 the major ovarian and uterine changes occurring during the cycle, and the hormones that are responsible for each of these changes.
 - 1.2 the two major reproductive events that occur during the cycle and the hormones involved
 - 1.3 the length of the average ovarian cycle and what event marks day "1"
 - 1.4 identifying the two phases of the cycle and what marks the dividing point between the two phases
 - 1.5 the feedback mechanisms that are in operation during the cycle
 2. Describe the changes occurring in the ovarian cycle with fertilization. The description should include:
 - 2.1 the source of Human Chorionic Gonadotropin (HCG), its secretory pattern and its major function
 - 2.2 the life span of a corpus luteum in the pregnant woman as compared to its life span in the nonpregnant woman
 - 2.3 the major reasons for maintaining the corpus luteum in pregnancy
 - 2.4 the secretory patterns of estrogens and progesterone in the pregnant woman as compared to those in the nonpregnant woman
 - 2.5 the principle sources of estrogen and progesterone in the pregnant and nonpregnant woman
 3. Define menopause and describe its effects on ovarian hormone and gonadotropin secretion.
 4. Describe the functions of the ovarian hormones, including those on the oral cavity. Define pregnancy gingivitis.
 5. Describe the major effects of prolactin and its regulation. Include its source of secretion and its pattern of secretion during and after pregnancy.

6. Describe the possible mechanism by which prolactin may act as a contraceptive.

E. Adrenal Gland

1. Identify the general microanatomy of the adrenal gland, and describe the three (3) major groups of hormones produced from the three (3) zones of the adrenal cortex.
2. Describe the general synthesis, transport and cellular target of the lipophilic, (steroid) adrenal cortical hormones.
3. Describe the function and the regulation of the mineralocorticoids (aldosterone)
4. Describe the hypothalamic-pituitary-adrenal cortex regulation for the secretion of the glucocorticoids (cortisol) and recognize the influence of diurnal rhythm and stress.
5. Identify the major glucocorticoid and describe the functions of the glucocorticoids, including their action on inflammation and the immune system.
6. Describe the major symptoms that one would expect from an excessive secretion of the glucocorticoids (Cushings Syndrome), and the major symptoms of these steroid hormones.
7. Describe the major actions of the adrenal androgens.

F. Thyroid Gland

1. Identify the thyroid hormones by name; and describe the general synthesis, secretion, and transport of the thyroid hormones.
2. Compare thyroxine and triiodothyronine in reference to their concentrations, potencies and durations of action.
3. Identify the major multiple effects of the thyroid hormones.
4. Describe the hypothalamic-pituitary-thyroid regulation of secretion for the thyroid hormones and recognize the role of stress in humans and the affect of hypothermia in infants.
5. Name four (4) major actions of Thyroid Stimulation hormone (TSH).
6. Describe the major types, symptoms, and causes of thyroid dysfunctions.
7. Identify the major symptoms and etiology of Graves disease.

G. Endocrine Control of Growth

1. Identify three (3) hormones which control Calcium and Phosphate metabolism.
2. Identify the normal distribution of Calcium in mineralized tissue, and in intracellular and extracellular fluid.
3. Describe four (4) essential activities of plasma and intracellular calcium.

4. Recognize the importance for the homeostatic regulation of calcium and phosphorus.
5. Describe the site of synthesis and general structure of parathyroid hormone.
6. Describe the major actions and targets of parathyroid hormone.
7. Identify the difference between fast and slow exchange of Calcium across the osteocytic-osteoblastic bone membrane.
8. Identify the site of synthesis, general structure, regulation of secretion of Calcitonin.
9. Describe the general action of Calcitonin.
10. Describe the general structure, activation steps, and tissues involved in the synthesis of "active" Vitamin D3.
11. Describe the major functions of active Vitamin D3 on calcium and phosphate metabolism and its role on the intestines, and bone.
12. Identify causes of, and major symptoms of moderate/severe hypoparathyroidism in humans.
13. Identify a major cause of, and symptoms of hyperparathyroidism in humans.
14. Identify a major cause of, and symptoms of Vitamin D deficiency in humans.
15. Describe the major aspects of osteoporosis, including risk factors, etiologies, and treatments.

H. Endocrine Control of Growth

1. Examine a normal growth curve in humans and identify the major hormones and the major non-endocrine factors responsible for growth.
2. Describe the metabolic actions and growth-promoting actions of growth hormone (GH) and of somatomedin.
3. Differentiate between the terms somatotrophin (STH), somatostatin, and somatomedin (IGF-1).
4. Describe the control of growth hormone secretion and somatomedin production.
5. Describe the major disorders associated with alterations in production of GH in humans.

I. Pancreas and Insulin

1. Describe the basic histology of the endocrine pancreas and the paracrine function of the islets.

2. Describe the basic structure and synthesis of insulin.
 3. Describe the functions of insulin.
 4. Describe the regulation of insulin secretion.
- J. Counter Regulatory Hormones
1. Describe the metabolic functions and regulation of glucagon.
 2. Describe the metabolic functions and regulation of growth hormone.
 3. Describe the metabolic functions and regulation of glucocorticoids (cortisol).
 4. Describe the metabolic functions and regulation of the catecholamines.
- K. Hormonal control of glucose
1. Define absorptive and postabsorptive states and identify the major hormones that are involved each state.
 2. Describe the major metabolic events occurring during starvation, and the respective roles of the metabolic hormones.
 3. Identify the major sources of fuel for the "resting" muscle; describe the utilization of fuels during exercise.
 4. Describe the major characteristics of hypoglycemia.
- L. Control of Food Intake
1. Describe the concept of energy balance using the first law of thermodynamics.
 2. Describe calorimetry and indicate the caloric value for each of the three major nutrients.
 3. Describe the regulation of food intake and the factors involved including their location.
 4. Define obesity and describe some of the theories of obesity.
- M. Temperature Regulation
1. Recognize the normal interaction of heat input to output for the homeostatic regulation of constant body (core) temperature.
 2. Identify and describe 4 physical means by which heat is exchanged between the heat generating core and the external environment.
 3. Identify and describe the primary means for heat gain in humans compared to infants.

4. Describe the major mechanisms for temperature regulation, and the neural locations of the temperature regulatory center.
5. Describe the general mechanism for the production of a “fever” in humans.
6. Identify the symptoms and cause of the “chills” and for the “crisis” of a fever.
7. Distinguish between exercise-induced and malignant hyperthermia.

RESOURCES

I. Media Resources

A. Printed media

Required textbook

Sherwood, L.
Human Physiology, 6th ed.
Thomson Brooks/Cole, 2007

B. Non-printed media

1. Videotapes

Boyd, I.A.
The Muscle Spindle (15 min.)
Catalog #1448

Hutchins, M. and Wiersema V.
Controlling Osmolarity in Clinical Solutions (18 min.)
Tape #1447

II. Faculty

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STUDY PLAN AND REQUIREMENTS

It is mandatory that for satisfactory completion of the course, Physiology I, students participate in all scheduled lectures and laboratories. This participation should be preceded by a review of the objectives for each lecture and the assigned media resources. Instructors may give assignments, and these assignments must be addressed by the student and turned into the specific instructor. The required textbook, monographs and videotapes need to be studied in order to understand and complete the objectives.

DENF 1541 PHYSIOLOGY I 2009 Fall Semester Schedule

Sessions: Wed, 8-8:50 am; Fri, 8-9:50 am

| DATE AND TIME | | | SESSION TOPICS | PRESENTERS |
|---------------|--------|-----------|-------------------------------------------------------------------|------------|
| Wed | Aug 19 | 8-8:50 am | Introduction | Faculty |
| Fri | Aug 21 | 8-9:50 am | Muscle Membrane | Turner |
| | | | Excitation | Turner |
| Wed | Aug 26 | 8-8:50 am | Excitation/Transmission | Turner |
| Fri | Aug 28 | 8-9:50 am | Nerve/Muscle Connection | Turner |
| | | | Nerve/Muscle Connection | Turner |
| Wed | Sep 2 | 8-8:50 am | Sliding Filament Mechanism | Turner |
| Fri | Sep 4 | 8-9:50 am | Excitation-Contraction Coupling | Turner |
| | | | Muscle Metabolism | Turner |
| Wed | Sep 9 | 8-8:50 am | Muscle Mechanics | Turner |
| Fri | Sep 11 | 8-9:50 am | EXAM I Room 207 | Turner |
| Wed | Sep 16 | 8-8:50 am | Autonomic Nervous System | Turner |
| Fri | Sep 18 | 8-9:50 am | Oral Cavity | Turner |
| | | | Esophagus | Turner |
| Wed | Sep 23 | 8-8:50 am | Stomach | Turner |
| Fri | Sep 25 | 8-9:50 am | Liver and Pancreas | Turner |
| | | | Small Intestine-Digestion | Turner |
| Wed | Sep 30 | 8-8:50 am | Small Intestine-Absorption | Turner |
| Fri | Oct 2 | 8-9:50 am | Absorptive Colon Storage Colon, Rectum | Turner |
| Wed | Oct 7 | 1-2:50 pm | EXAM II Room 207 | Turner |
| Fri | Oct 9 | 8-8:50 am | Introduction to Endocrinology | Weisbrodt |
| | | 9-9:50 am | Hypothalamic/Hypophyseal System | Weisbrodt |
| Wed | Oct 14 | 8-8:50 am | Male Reproductive Hormones | Weisbrodt |

| DATE AND TIME | | | SESSION TOPICS | PRESENTERS |
|---------------|--------------|------------------|----------------------------------------------------|-------------------------------|
| Fri | Oct 16 | 8-8:50 am | Female Reproductive Hormones | Weisbrodt |
| | | 9-9:50 am | Adrenal Gland | Hutchins |
| Wed | Oct 21 | 8-8:50 am | Thyroid Gland | Hutchins |
| Fri | Oct 23 | 8-8:50 am | Calcium metabolism | Hutchins |
| | | 9-9:50 am | Calcium metabolism | Hutchins |
| Wed | Oct 28 | 8-8:50 am | Calcium Cases | Hutchins/Biochem |
| Fri | Oct 30 | 8-9:50 am | EXAM III Room 207 | Faculty |
| Wed | Nov 4 | 8-8:50 am | Growth | Hutchins |
| Fri | Nov 6 | 8-8:50 am | Pancreas and Insulin | Weisbrodt |
| | | 9-9:50 am | Glucagon, Counter Regulatory Hormones | Weisbrodt |
| Wed | Nov 11 | 8-8:50 am | Endocrine case(s) | Hutchins/Weisbrodt |
| Wed | Nov 18 | 8-9:50 am | Hormonal control of Glucose – Case(s) | Hutchins/Levine/ Weisbrodt |
| Fri | Nov 20 | 8-8:50 am | Control of Food Intake | Weisbrodt |
| | | 9-9:50 am | Temperature Regulation Course Evaluation | Hutchins |
| Wed | Nov 25 | 8-8:50 am | Review | Hutchins/Weisbrodt |
| Fri | Nov 27 | | <i>Thanksgiving Holiday</i> | |
| Wed | Dec 2 | 1-2:50 pm | FINAL EXAM Room 207 | Faculty |

EVALUATION METHODS

During the course there will be three (3) unit examinations. These examinations will consist of true/false, multiple-choice, short answer, and essay questions. There will be no remakes of these examinations during the semester.

Additionally, a comprehensive, National Board-type final examination will be administered during "Finals Week." The final exam will represent 25% of the course grade. **Students are required to make a grade of at least 70% on the final examination.** The weights of each exam are listed below.

| | |
|-------------------|------------|
| Exam 1 | 25% |
| Exam 2 | 25% |
| Exam 3 | 25% |
| Final Exam | 25% |

Remediation and remake examinations will be administered according to the current *Dental Branch Student Guide to Academic Studies*.