

## **CAPS 206 Course Syllabus**

### ***CAPS 206. Fundamentals of Physiology in Human Health and Disease II (3 Credits)***

#### ***Academic Calendar Description:***

*The principles of physiological regulation of respiratory, renal, gastrointestinal, endocrine and reproductive systems in the human body with practical applications in health and disease. [3-0-0]  
Credit will only be granted for one of CAPS 301 or CAPS 206*

#### ***Prerequisites***

*BIOL 112, CHEM 123, MATH 101, and 100-level PHYS beyond PHYS 100.*

***Corequisites:*** None

***Instructional Schedule:*** 3 x 50 min sessions each week

### **Course Overview**

Principles of normal physiology and common human disorders across respiratory, renal, gastrointestinal, endocrine, metabolism and reproductive systems will be integrated to explain the maintenance of organism homeostasis in the presence of physiological stressors. Emphasis will be placed on the application of common physiology principles to gain understanding of each system's integrated roles in the body.

### **Course Structure**

There will be three 50-min sessions per week. Each session consists of an online module accessed via the course CANVAS site, and both asynchronous and in-person classes.

### **Course Co-Directors**

**Dr. Barry Mason** barry.mason@ubc.ca

**Dr. Christina Hull** christina.hull@ubc.ca

### **Student Expectations**

Students are required to read all online modules, using session objectives to guide learning topics. Students are expected to complete all examinations and achieve an overall grade of 50% to pass the course.

### **Course Structure**

There will be three 50-min sessions per week. Each session consists of an online module accessed via the course CANVAS site, and both asynchronous and in-person classes.

### **Learning Activities**

This course will be comprised of a combination of synchronous and asynchronous sessions. Supportive material will be provided prior to each session. Advanced study may be required

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to facilitate in-class discussions.

### **Learning Materials**

All learning material is taken from a combination of textbooks, online resources (provided via CANVAS). All lecture materials will be provided in PDF format on CANVAS prior to the start of term.

**Recommended Text: Human Physiology, Sherwood and Ward, 5<sup>th</sup> Canadian Edition, 2021**

### **Approach to Readings – Navigating information**

**Background:** In this age, you have access to an abundance of information through a variety of media, most notably via online searching. We endeavor to develop your critical reading skills and encourage/help you make decisions regarding the relevance of the resource material you consume, and to develop a confidence that you can effectively be a self-learner.

This is a valuable skill set as a scholar and will be needed as an independent learner throughout the remainder of the CAPS program.

### **Approach to using supplementary materials:**

- Assigned readings in this course will be deliberately general, consisting of the identification of relevant chapters in the recommended text
- We ask that you cross-reference the lecture handout material with the textbook headings in the identified chapters.
- The textbook has a greater breadth and scope of material than does CAPS 205/206.
- Through this process you will have to make decisions about the relevance of material in the text in relation to the vetted, and paired down, material in course handouts and sessions.
- The remainder of the textbook material not directly covered in course sessions will serve as a peer-reviewed resource to help students fill their personal knowledge-gaps in physiology.

### **Learning Outcomes**

At the successful completion of this course, students will be able to:

1. Apply a systematic approach to the understanding of physiological roles of organ systems in whole body homeostasis by identifying and describing:
    - The input to the system and how is this being measured
    - The structures, and mechanisms for input processing
    - The action taken in response to the input.
    - The physiological compensation to the measured input
  2. Predict physiological responses to variable inputs into each of the physiological systems covered in this course.
  3. Apply principles of normal physiology to disorders of normal function for the systems covered in this course; respiratory, renal, gastrointestinal, endocrine, energy metabolism and reproductive systems.
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**Schedule of Topics (36 x 50 min Sessions Total)**

Introduction to Physiological Principles (1 Session)

- Think like a physiologist
- input measurement, integration in regulation centres, system output, compensation

1 Respiratory system (7 sessions)

Following this set of lectures you should be able to:

- Describe the roles of the respiratory system in the body and organisation and structure of the respiratory system
- Describe the upper airway the function of each component in the handling of air
- Distinguish between conducting and respiratory zones of the tracheobronchial tree
- Applying principles of normal physiology to predict and explain disruptions of upper airway function system function
- Describe the elastic properties of the respiratory systems and the effects of recoil on transmural pressure
- Describe the changes in pressures, and lung volume during breathing.
- Describe the muscles, and their innervation and their contraction sequence, involved in breathing and relate to changes in pressure.
- Describe how airway size relates to airway resistance and the role of the autonomic nervous system in regulating airway size
- Describe lung volumes measured during breathing with a spirogram during both restful state and during exercise
- Define ventilation and the relationship between ventilation and perfusion.
- Describes the mechanism of gas exchange with respect to the partial pressure of O<sub>2</sub> and CO<sub>2</sub>
- Explain how O<sub>2</sub> and CO<sub>2</sub> are transported in the blood and the factors contributing to the delivery of blood gases to and from body tissues
- Describe how breathing is controlled and how the rate and depth of breathing respond to physiologic stressors and during abnormal stressors

Assigned readings for these sessions.

**Human Physiology**, Sherwood and Ward, 5<sup>th</sup> Canadian Edition, 2021.

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Respiratory Chapter 13

2. Renal System (7 sessions)

Following this set of lectures you should be able to:

- Describe the roles of the kidney in the body and structural organisation of the functional unit of the kidney, the nephron and the flow of fluid through the system.
  - Discuss the functional role of the nephron in excretion and distinguish between filtration, reabsorption, & secretion
  - Glomerular Filtration
    - Describe the barriers involved in filtration and explain how various pressure components within the renal corpuscle determine GFR
    - Explain how changes in vascular resistance alter GFR
    - Describe the regulatory mechanisms involved in maintaining a relatively stable GFR
  - Renal Transport
    - Describe the unique properties of epithelial cells and consider how each of these properties influence transport along the nephron
    - Describe the major pathways of Na<sup>+</sup> transport along the nephron and consider how the distribution of transporters (apical/basal) in each region allows for regulation of this transport
    - Explain the consequences of axial specialization of successive nephron segments, predict what will happen to function of downstream segments if an upstream segment fails, and consider why this might be therapeutically useful
    - Describe how reabsorption in the proximal tubule alters tubular fluid characteristics and explain how each of the above alterations occur
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    - Describe the major pathways of K<sup>+</sup> transport along the nephron, explain how the handling of K<sup>+</sup> differs between normal, low, and high K<sup>+</sup> levels, and discuss the impact the altered handling has on the amount of K<sup>+</sup> excreted
  - Acid-Base Physiology
    - Consider the endogenous & exogenous acid sources and outline how alterations of acid levels occur
    - Describe the pathways for HCO<sub>3</sub><sup>-</sup> reclamation/generation in the proximal tubule and explain how these pathways act to accommodate an increased acid load
    - Compare and contrast compensation mechanisms for acid-based disturbances and detail renal compensation mechanisms
  - Urine Concentration
    - Explain how the loop of Henle generates an osmolality gradient along the renal medulla and consider how this gradient can be used to concentrate or dilute the final urine (with respect to plasma)
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- Compare and contrast the roles of active Na<sup>+</sup> transport and passive urea transport in establishing the medullary osmotic gradient
- Describe countercurrent exchange and explain how it contributes to maintenance of the medullary osmotic gradient
- Consider the importance of urine concentration to urea excretion and the consequences for fluid balance
- Explain how the bladder is able to store urine (fill) with only minimal increases in intravesical pressure
- Describe the micturition reflex pathway, be sure to differentiate between the automatic spinal component and the voluntary component
- Regulation of Body Fluid Osmolality and Volume
  - Describe the role of AVP in regulating body fluid osmolality and outline the regulation of AVP release
  - Explain the mechanism by which AVP is able to restore normal plasma osmolality and blood volume/pressure in response to disturbances
  - Consider both the short- and long-term responses to alcohol/caffeine intake (with respect to kidney function)
  - Describe how the juxtaglomerular apparatus responds to changes in blood pressure (consider both increased and decreased blood pressure)
  - Diagram the renin-angiotensin-aldosterone system and use the diagram to explain the major role(s) of this pathway in the regulation of body fluid volume

Assigned readings for these sessions

**Human Physiology**, Sherwood and Ward, 5<sup>th</sup> Canadian Edition, 2021.  
Renal. Chapters 14 and 15

**Session: Midterm exam (1 Session)**

3. Gastrointestinal (7 sessions)

- Describe the roles of the gastrointestinal system in the body and components that comprise the system
  - Describe the four basic GI processes: motility, secretion, digestion and absorption.
  - Motility: Differentiate between mixing and propulsive movements in the GI tract lumen.
  - Secretions: Describe how GI exocrine glands produce and secrete their products.
  - Digestion: Outline the enzymes involved in, and the products of, the digestion of proteins, fats and carbohydrates.
  - Absorption: Describe the sites of nutrient absorption in the GI tract
  - Gross Anatomy: Identify the GI tract organs and the accessory organs that comprise the GI system.
  - Anatomy: Describe the 4 layers of the wall of the GI tract and state the function of each.
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- Describe how intrinsic muscle excitability, the enteric nervous system, the autonomic nervous system and hormonal influences regulate GI tract function.
  - Mouth to Stomach
    - Secretion: Describe the components of salivary secretions and state their function and the factors controlling their release.
    - Motility: Describe the sequence of events contributing to, and factors that control, swallowing.
    - Digestion: Identify the nutrients/substances that are digested in the mouth and how they are digested.
    - Esophagus: Describe the role of the esophagus in swallowing. What is peristalsis and how is this coordinated?
  - Stomach
    - Motility: Differentiate between gastric filling, storage and mixing processes in the stomach and state the control mechanism(s) for each.
    - Motility: Describe the process of gastric emptying, why this is a tightly regulated process and the factors that control gastric emptying.
    - Secretions: Differentiate between gastric gland and gastric pits and list the products secreted by each in different regions of the stomach.
    - Secretions: Describe the gastric exocrine secretions, their function and the factors controlling their production and release.
    - Secretions: Describe the gastric paracrine and endocrine secretions, their function and the factors controlling their production and release.
    - Digestion: Explain how carbohydrate and protein digestion occur in the stomach.
  - Pancreas and Biliary System
    - Pancreatic Secretions: Identify each of the secretions of the pancreas and discuss their function and control mechanism(s).
    - Liver: Describe the anatomical and functional organisation of the liver.
    - Liver: Describe the hepatic-portal circulation. Why is this system unique?
    - Liver: Outline the enterohepatic circulation and explain the functional importance of this organisation.
    - Liver Secretions: Detail the components in bile and discuss the function of bile in fat digestion
    - Liver Secretions: Describe the factors that stimulate bile production and secretion and how bile production stops.
  - Small Intestine
    - Describe the anatomical components of the small intestine and state a function for each.
    - Motility: Differentiate between segmentation and the migrating motility complex and state the function and control mechanism(s) for each.
    - Secretions: Identify the secretions of the small intestine and discuss their function and control mechanism(s).
    - Digestion: Outline the steps involved in the digestion of protein, fats
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- and carbohydrates in the small intestine.
- Absorption: Describe the specific adaptations of the small intestine lumen to increase surface area. Explain why a large surface area is important.
- Absorption: Describe the steps involved in the absorption of proteins, fats and carbohydrates in the small intestine. Explain the relevance of secondary active transport.
- Absorption: Explain how water is absorbed and the importance of active Na<sup>+</sup> uptake in this process.
- Absorption: Describe how calcium and iron absorption differ from the three main nutrients.
- Absorption: Describe how the GI tract maintains acid-base balance and the complications of diarrhea.
- Large Intestine
  - Describe the anatomical components of the large intestine and state a function for each.
  - Motility: Differentiate between haustral contractions and mass movements and state the function and control mechanism(s) for each.
  - Motility: Describe the defecation reflex and factors that control defecation.
  - Motility: Define constipation and discuss its potential causes and complications.
  - Secretions: Identify the secretions of the large intestine and discuss their function and control.
  - Digestion: Does digestion occur in the large intestine? If so, identify digestion products.
  - Digestion: Describe the benefits of colonic bacteria.
  - Absorption: Identify substances that are absorbed by the large intestine and factors that influence this absorption.

Assigned readings for these sessions

**Human Physiology**, Sherwood and Ward, 5<sup>th</sup> Canadian Edition, 2021.

Gastrointestinal Chapter 16

#### 4. Endocrine System and Signalling (5 sessions)

Following the Introduction to Endocrinology lecture you should be able to:

- Describe the difference between exocrine and endocrine glands
  - List and describe the chemical classes of hormones
  - Describe negative feedbacks. Why are positive feedbacks rare?
  - Describe the modes of delivery of hormones to target tissues
  - Describe locations of receptors and the importance of the hormone-receptor complex
  - Describe general structure of the pituitary gland
  - Compare and contrast the structure and function of the anterior and posterior pituitary
- Compare and contrast structural and functional relationship between the anterior and posterior pituitary, and the hypothalamus
- List hypothalamic and anterior pituitary hormones
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- Describe the role of each hypothalamic hormone in regulating the release of corresponding anterior pituitary hormones
- Describe endocrine regulation of growth
- Describe synthesis and functions of thyroid hormones and discuss pathology of the thyroid gland
- Describe structure and function of the adrenal glands
- Describe the principles of endocrine control of calcium metabolism

Assigned readings for these sessions.

**Human Physiology**, Sherwood and Ward, 5<sup>th</sup> Canadian Edition, 2021.

Endocrine. Chapters 6 and 7

### 5. Energy Metabolism and Glucose Regulation (3 sessions)

Following this set of lectures you should be able to:

- Describe carbohydrate, lipid and protein metabolism, anabolic and catabolic hormones and outline the major pathways of carbohydrate, lipid and protein metabolism
- Discuss fuel metabolism during absorptive and post-absorptive states, the differences between absorptive state and post-absorptive state, the major sources of energy during absorptive state, the major sources of energy during post-absorptive state, and what happens during prolonged fasting
- Describe the hormonal regulation of carbohydrate metabolism
- Describe the endocrine and exocrine pancreas and detail the structure and function of pancreatic islets

Blood glucose regulation: Insulin and Glucagon

- Discuss the structure, synthesis, and metabolism of insulin
- Describe the regulation of insulin secretion  
The intracellular mechanisms involved in the insulin secretion by beta cells
- Describe the location and structure of the insulin receptor, and its role in the regulation of carbohydrate, lipid and protein synthesis
- Describe the structure, synthesis of glucagon and the glucagon receptor
- Discuss the regulation of glucagon secretion and the role of glucagon in the glucose regulation

Diabetes

- Apply your understanding of blood glucose metabolism and regulation to discuss the signs, symptoms and treatments for diabetes mellitus.
- Differentiate between type 1 and type 2 DM.

Assigned readings for these sessions

**Human Physiology**, Sherwood and Ward, 5<sup>th</sup> Canadian Edition, 2021.

Energy Metabolism and Glucose Regulation      Chapter 17

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**6. Reproduction (3 sessions)**

Male Reproductive physiology

- Describe general anatomy of the male reproductive system
- Describe general anatomy of the testis and outline the process of spermatogenesis
- Describe hormonal mechanisms that regulate male reproductive functions

Female Reproductive Physiology

- Describe general anatomy of the female reproductive system
- Describe production of ova (eggs) by the ovary
- Identify the phases and describe the events of the ovarian and uterine cycles
- Describe hormonal mechanisms that regulate the female reproductive functions during pregnancy.
- Describe the events occurring between fertilization and implantation
- Describe basic anatomy and functions of the placenta
- Compare and contrast the hormonal control of pregnancy provided by the corpus luteum and the placenta

Assigned readings for these sessions

**Human Physiology**, Sherwood and Ward, 5<sup>th</sup> Canadian Edition, 2021.

Reproductive System Chapter 18

**8. Systems Integration (2 sessions)**

- Apply the principles of normal physiology and describe the integrated physiological mechanisms in response to hemorrhage. Identify the variable being measured, the control centres involved and the compensation to identified stressors.

**Assessments of Learning**

Assessment is in the form of 2 invigilated exams, covering sessions not covered by a priorexam and two assignments detailed below.

Assignments x 2 @ 10% each; submitted to Canvas	20%
Midterm Exam (MCQ)	30%
Final Exam (Comprehensive; MCQ and short answer questions)	50%

**Assignment Details and Rubric**

Each student will choose a disease condition from a provided list. For each condition, students will draw and label a diagram outlining the normal physiological processes of that relevant system, and identify sites of dysregulation that result in the signs and symptoms of the disease condition. Students will then **record themselves** verbally describing both the normal physiology, and what processes are not normal in the disease state, using the diagram as a visual aid (e.g. voice over powerpoint), explaining the signs and symptoms of the disease. The intended audience for the discussion is a hypothetical family member who is experiencing the disease condition.

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**Grading Rubric for Physiology of Disease Assignments (worth 10% of grade)**

Category	Outstanding	Meets Standards	Below Required Standards	Inc.*	Score
Normal Physiology Discussion	5 A clear, concise and accurate verbal discussion of the normal physiology of the relevant system	3 A clear, and accurate verbal discussion of the normal physiology of the relevant system	1 The discussion of the normal physiology of the relevant system is neither clear nor accurate	0	5
Dysregulation Leading to Symptoms Discussion	5 A clear, concise and accurate verbal discussion of the abnormal physiology leading to the disease condition of the relevant system	3 A clear, and accurate verbal discussion of the abnormal physiology leading to the disease condition of the relevant system	1 The discussion of the abnormal physiology leading to the disease condition of the relevant system is neither clear nor accurate	0	5
Diagram used to explain normal and abnormal physiology of relevant system	5 A clear, concise and accurate diagram of the normal physiology of the relevant system; identification of what went wrong in the disease state	3 A somewhat clear, and accurate diagram of the normal physiology of the relevant system; identification of what went wrong in the disease state	1 The diagram of the normal and abnormal physiology of the relevant system is neither clear nor accurate	0	5

\*Incomplete

**University Policies**

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all their actions. Details of the policies and how to access support are available at the Policies and Resources section of the UBC Senate website.

**Academic Integrity**

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing

them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise, and harsh sanctions are imposed. For example, incidents of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President’s Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

A more detailed description of academic integrity, including the University’s policies and procedures, may be found in the Discipline for Academic Misconduct section of the UBC Academic Calendar.

No assignment may be submitted to any other instructor of any course for a grade. The minimum penalty for plagiarism in any assignment is a zero for the paper; the maximum penalty is a zero for the course.

### **UBC Grading Standards**

#### **Undergraduate Grading Scale**

Percentage (%)	Letter Grade
90-100	A+
85-89	A
80-84	A-
76-79	B+
72-75	B
68-71	B-
64-67	C+
60-63	C
55-59	C-
50-54	D
0-49	F

### **Land Acknowledgement**

UBC’s Point Grey Campus is located on the traditional, ancestral, and unceded territory of the xwməθkwəy̓ əm (Musqueam) people. The land it is situated on has always been a place of learning for the Musqueam people, who for millennia have passed on in their culture, history, and traditions from one generation to the next on this site.

### **Copyright**

All materials of this course (course handouts, lecture slides, assessments, course readings, etc.) are the intellectual property of Barry Mason and Christina Hull or licensed to be used in this course by the copyright owner. Redistribution of these materials by any

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