



COURSE OUTLINE SUMMER 2021

Course:	Physiology
Course Code:	SPH102
Times & Location:	Online Tutorial: Thursdays 7:30 – 9:00 pm EST
Course Coordinator:	Dr. Maria Shapoval, ND
Instructors/Teaching Assistants:	Dr. Maria Shapoval, ND
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Office Hours:	By appointment
Office Location:	Online

Evaluation:

	PERCENT	TEST DATE / DUE DATE
Tutorial Participation/ Attendance	5%	Weekly tutorial
Module Quizzes	10%	Weekly Quizzes
Assignment	5%	Assignment due April 8, 2021
Midterm Test	30%	March 25, 2021
Final Exam	50%	April 22, 2021

Plagiarism and cheating are academic offenses and will be treated seriously by the College. Students should refer to the College's policies on academic misconduct posted on in the **Academic Calendar**. Students may seek guidance from a number of style manuals located in the CCNM library.

Required Texts:

Dee Unglaub Silverthorne *Human Physiology: An Integrated Approach (8th Edition)*. Published by Pearson.

Course Description:

Physiology (SPH102) is a three-credit, eight-week course that continues and builds on the concepts taught in SPH101. It will provide students with a solid core foundation in applied physiology. The course will emphasize clinical physiology including the integrative functions of the major systems of the human body as well as metabolism, growth and aging. Topics will include the cardiovascular system, gastrointestinal system, kidney, and reproductive systems.

The application of physiology fundamentals to naturopathic medicine is integrated throughout the course, providing students with a unique opportunity to learn physiology within the context of naturopathic medicine.

Course Outcomes:

On completion of the course the student will be expect to:

- Demonstrate knowledge of organ systems function
- Demonstrate knowledge of cellular function
- Demonstrate the ability to integrate physiology from the cellular and molecular level to the organ system
- Effectively read and communicate scientific information
- Apply understanding of physiological processes in the clinical setting

Pedagogy:

The course is delivered in a blended learning style which combines online self-study modules with weekly live interactive online tutorial sessions from 7:30 - 9 p.m. EST (one evening per week) with the course instructor.

Evaluation:

The passing grade is 60%, and evaluations/assessments will consist of tutorial attendance/participation (5%), one quiz per module (10%), one assignment (5%), one midterm test (30%), and a final exam (50%). Both midterm and final exams will be invigilated at CCNM's testing centre as part of the course, or under the guidance of a suitable invigilator (college/university or secondary school academic professional, librarian, or testing centre) in your local area, costs of which will be the responsibility of the student.

SPH102 – Physiology

Lecture Schedule

Class	Date	Topic	Modules
1	July 8, 2021	Introduction to course & Module 1 & 2	Cardiovascular System & Blood Flow and Pressure
2	July 15, 2021	Modules 3	Blood
3	July 22, 2021	Module 4 & 5	Mechanics of Breathing & Gas Exchange
4	July 29, 2021	Midterm Exam Week	
5	August 5, 2021	Modules 6	Kidney
6	August 12, 2021	Module 7 & 8	Digestive System & Metabolism and Energy Assignment #1 – deadline August 12, 2021
7	August 19, 2021	Modules 9 & 10	Endocrine Control of Growth & Reproduction and Development
8	August 26, 2021	Final Exam Week	

The Academic Department reserves the right to make schedule changes.

SPH102 - Physiology

Session Learning Outcomes

Tutorial 1

Date: July 8, 2021

Introduction to SPH102 Physiology Course, Cardiovascular Physiology & Blood Flow and Control of Blood Pressure

By the end of this session, the student will be able to:

- Navigate Moodle SPH100 course shell, GoogleDocs and GoToWebinar programs
- Discuss plagiarism
- Understand course requirement, including textbook readings, evaluations and deadlines
- Begin completion of Modules 1 and Module 2
- Describe the functions of the cardiovascular system and give examples of each function. Describe the organization of the cardiovascular system, starting and ending in the aorta.
- Define and explain the relationships among pressure, hydrostatic pressure, pressure gradients, flow, velocity of flow, resistance, and radius as they relate to the cardiovascular system.
- Describe in detail the internal and external anatomy of the heart.
- Describe the two types of myocardial cells and their arrangement in the heart.
- Describe the membrane proteins and ion movement involved in myocardial excitation-contraction coupling and relaxation.
- Compare and contrast actions potentials of myocardial autorhythmic and contractile cells.
- Describe the conduction of electrical signals through the heart.
- Describe the parts of an electrocardiogram and explain how these electrical events are related to the mechanical events of the cardiac cycle.
- Explain the pressure changes that occur during the cardiac cycle and their relationship to flow through the heart and blood vessels.
- Explain the relationship of heart rate, cardiac output, and stroke volume.
- Explain the role of the autonomic divisions in control of heart rate at the cellular and molecular level.
- Explain how the following factors influence stroke volume: venous return, length-tension relationships, preload, afterload, contractility, skeletal muscle pump, respiratory pump, inotropic agents.
- Compare and contrast the structure, mechanical properties, and functions of the five major types of blood vessels.
- Explain what creates blood pressure and how blood pressure changes as blood flows through the systemic circulation.
- Explain the relationship between blood flow, pressure gradients, and the resistance of the system to flow. Use Poiseuille's Law to explain the factors that influence resistance.
- Describe how blood pressure is estimated using sphygmomanometry.
- Explain the contributions of cardiac output and peripheral resistance to blood pressure. Calculate mean arterial pressure.
- Explain how changes in blood volume affect blood pressure.
- Define myogenic autoregulation and explain its role in altering local blood flow.
- List and describe the major paracrine molecules involved in local control of blood flow. Describe the hormonal and neural control of blood vessel diameter, including significant neurotransmitters and their receptor types.
- Explain how the body can use local and long-distance signaling to direct blood flow to or away from specific organs or tissues.
- Describe in detail the steps of the baroreceptor reflex, including the stimulus, sensor, input pathway, integrating center(s), output pathways, target(s), cellular response(s), tissue response(s), and systemic response(s). Include all chemical signal molecules and their receptors as well as any feedback loops.
- Describe the different types of capillaries and where they are found in the body.
- Explain why the velocity of blood flow is lowest in the capillaries.
- Explain the role of diffusion and transcytosis in capillary exchange.

- Explain the forces that influence capillary filtration and absorption.
- Describe the anatomy and functions of the lymphatic system and how the lymphatics are related to the circulatory and immune systems.
- Explain the pathological factors that might alter capillary exchange and result in edema.
- List the controllable and uncontrollable risk factors for cardiovascular disease.
- Describe the progression of events that result in atherosclerosis.
- Explain why hypertension represents a failure of homeostasis

Deadline: Post a brief introduction on “Please introduce yourself” forum before the start of the tutorial.

Tutorial 2

Date: July 15, 2021

Blood

By the end of this session, the student will be able to:

- Describe the composition of plasma and list the major functions of plasma proteins.
- List the cellular elements of blood, including immature forms and subtypes, and describe the function(s) and distinguishing characteristics of each.
- Describe the differentiation of blood’s cellular elements, starting from a pluripotent hematopoietic stem cell and including key cytokines involved in development.
- List the components of a complete blood count.
- Compare the structures of immature and mature red blood cells.
- Describe the molecular structure of hemoglobin.
- Create a map of iron metabolism and hemoglobin synthesis.
- Describe the common pathologies of red blood cells.
- Describe the production, structure, and functions of platelets.
- Distinguish between hemostasis and coagulation.
- Diagram the key steps of hemostasis, coagulation, and fibrinolysis.

Deadline: Complete Modules 1, 2 and 3 before the start of the tutorial.

Tutorial 3

Date: July 22, 2021

Mechanics of Breathing & Gas Exchange and Transport

By the end of this session, the student will be able to:

- List four major functions of the respiratory system.
- Diagram the anatomy of the respiratory system and explain the function of each structure.
- Explain and express mathematically the relationship between atmospheric pressure, water vapor pressure, and the partial pressures of individual gases.
- Explain the relationship between the pressure of a gas and the volume in which it is contained.
- Define and describe the lung volumes and lung capacities.
- Explain how pressures and lung volumes change during normal breathing, and how that affects air flow in the respiratory system.
- Explain how subatmospheric intrapleural pressure develops and the role it plays in normal breathing.
- Graph the alveolar and intrapleural pressure changes that occur during one respiratory cycle.
- Compare and contrast compliance and elastance in respiratory physiology, giving examples of disease states that demonstrate changes in compliance and/or elastance.
- Explain the role of surface tension and surfactants in respiratory physiology.
- Map the factors affecting airway resistance, with emphasis on local and reflex control mechanisms involved in bronchodilation and bronchoconstriction.
- Compare and contrast total pulmonary ventilation and alveolar ventilation.

- Explain why gas composition in the alveoli remains relatively constant during normal breathing and how it changes with hyper- and hypoventilation.
- Explain the local control mechanisms by which ventilation and alveolar blood flow are matched.
- Compare obstructive and restrictive lung diseases.
- List three arterial blood parameters that influence ventilation.
- Diagram the normal partial pressures of O₂ and CO₂ in the atmosphere, alveoli, arterial blood, resting cells, and venous blood.
- Describe all the factors that influence gas exchange between the atmosphere and arterial blood.
- Explain the difference between the concentration of a gas in solution and the partial pressure of that gas in solution, using O₂ and CO₂ as examples.
- Explain how the Fick equation uses mass flow and mass balance to relate cardiac output and cellular oxygen consumption.
- Explain the role of hemoglobin in oxygen transport from the molecular level to the systemic level.
- Describe the relationship between plasma O₂ P and oxygen transport. Draw the oxyhemoglobin saturation curve, explain the physiological significance of the shape of this curve, and draw the shifts in the curve that result from changes in pH, temperature, and 2,3-BPG.
- Compare and contrast oxygen transport on fetal and adult hemoglobin.
- Write the chemical reaction for the conversion of CO₂ to HCO₃⁻, including the enzyme that catalyzes the reaction.
- Map the transport of carbon dioxide in arterial and venous blood, including the exchanges of CO₂ between the blood and the alveoli or cells.
- Map the reflex control of ventilation including appropriate neurotransmitters and their receptors.
- Diagram the current model for the brainstem neural networks that control breathing.
- Explain the mechanisms by which central and peripheral chemoreceptors monitor CO₂ and O₂ levels.
- Describe the protective reflexes that guard the lungs.

Deadline: Complete Modules 4 and 5 before the start of the tutorial.

Date: Quiz 1, 2 and 3 – **Wednesday July 21, 2021**

Tutorial 4 – MIDTERM EXAM – NO TUTORIAL TODAY!

Date: July 29, 2021

*Deadline: Quiz 4 & 5 – **Tuesday July 27, 2021***

Tutorial 5

Date: August 5, 2021

The Kidneys

By the end of this session, the student will be able to:

- List and describe the six functions of the kidneys.
- Trace the anatomical path of a drop of water from Bowman's capsule to urine leaving the body.
- Trace the anatomical path of a drop of blood from the renal artery to the renal vein.
- Diagram the anatomical relationship between the vascular and tubular elements of the nephron.
- Describe the three processes of the nephron.
- Diagram the volume and osmolarity changes of filtrate as it passes through each section of the nephron.
- Describe the filtration barriers between the blood and the lumen of the nephron, and explain how they can be modified to control filtration. Describe the pressures that promote and oppose glomerular filtration.
- Define glomerular filtration rate and give average values for GFR.
- Explain how GFR can be influenced by local and reflex control mechanisms.
- Distinguish between transcellular transport and paracellular pathways.
- Describe and give examples of active and passive reabsorption in the proximal tubule.

- Using glucose as an example, create graphs to show filtration, transport maximum, and renal threshold of a substance reabsorbed by protein-mediated transport.
- Explain and give examples of the importance of tubular secretion in renal function.
- Explain mathematically and in words the relationship between the excretion of a solute and its renal clearance.
- Explain how clearance can be used as an indirect indicator of renal handling of a solute.
- Diagram the involuntary micturition reflex

Deadline: Complete Modules 6 before the start of the tutorial.

Tutorial 6

Date: August 12, 2021

The Digestive System & Metabolism and Energy

By the end of this session, the student will be able to:

- Trace a piece of undigested food from mouth to anus.
- Describe the four layers of the GI tract wall.
- Describe the primary function of the digestive system.
- Explain the challenges of autodigestion, mass balance, and defense. Describe and compare secretion, digestion, absorption, and motility.
- Describe single-unit smooth muscle, slow wave potentials, tonic and phasic contractions.
- Describe and compare peristalsis, segmentation, and the migrating motor complex.
- Compare the enteric nervous system to the central nervous system.
- Contrast long reflexes, short reflexes, and control involving GI peptides.
- Name the three families of GI hormones and give examples of each.
- Explain feedforward control in digestion.
- Map the processes and control pathways of the cephalic phase.
- Explain the functions of saliva and the process by which it is secreted.
- List the steps of the deglutition (swallowing) reflex.
- Explain the three functions of the stomach.
- Map the processes and control pathways of the gastric phase.
- Describe the gastric secretions and their major actions.
- Compare and contrast digestion and motility in the large and small intestine.
- Describe the anatomy and function of the hepatic portal system.
- Describe the major secretions of the pancreas and liver.
- Diagram the cellular mechanisms for secretion or absorption of water and ions.
- Diagram the digestion and absorption of carbohydrates, proteins, and fats.
- Explain the neural and hormonal control of the intestinal phase of digestion.
- Explain the role of bacteria in the gut.
- Describe the GALT.
- Contrast the protective reflexes of vomiting and diarrhea.
- Diagram the control pathways that influence hunger and satiety.
- Explain how we measure energy use and metabolic rate in humans.
- Identify the factors that affect metabolic rate.
- Distinguish between anabolic and catabolic pathways, and name as many specific pathways as possible.
- Distinguish between the fed (absorptive) state and the fasted (postabsorptive) state. Describe the possible fates of ingested nutrients and indicate which is the most common for each class of biomolecules.
- Create a map that summarizes the balance of nutrient pools and nutrient storage for carbohydrates, proteins, and lipids.
- Explain the regulatory significance of push-pull control.
- Create a summary diagram for anabolic metabolism of carbohydrates, proteins, and lipids in the fed state.

- Explain the relationship between different forms of cholesterol and cardiovascular disease.
- Create a summary diagram for catabolic metabolism of carbohydrates, proteins, and lipids in the fasted state.
- Explain the roles of insulin and glucagon in the control of metabolism
- Create a reflex map for insulin, including mechanisms of action where possible.
- Draw a reflex map for glucagon, including mechanisms of action where possible.
- Compare type 1 and type 2 diabetes mellitus. Explain how treatments for diabetes are related to the pathophysiology of the disease.
- Create a map for type 1 diabetes to show the body's responses to elevated plasma glucose in absence of insulin.
- Explain the normal routes of heat gain and loss for the human body.
- Map the homeostatic control of body temperature.

Deadline: Complete Modules 7 and 8 before the start of the tutorial.

*Deadline: Quiz 6 – **Wednesday August 11, 2021***

*Deadline: Assignment – due by midnight of **Thursday August 12, 2021***

Tutorial 7

Date: August 19, 2021

Endocrine Control of Growth and Metabolism & Reproduction and Development & Review

By the end of this session, the student will be able to:

- Explain endocrine feedback systems, how target cell responses are modulated, and the possible causes of endocrine pathologies.
- Diagram the pathway for steroid hormone synthesis from cholesterol.
- Diagram the HPA pathway in detail, including feedback signals and cellular mechanisms of action.
- Identify the hallmarks of hypercortisolism and hypocortisolism, and explain the possible causes.
- Identify additional physiological functions of CRH and ACTH.
- Diagram the synthesis and secretion of thyroid hormones.
- Diagram the thyroid hormone control pathway, including feedback signals and cellular mechanisms of action. Identify the hallmarks of hyperthyroidism and hypothyroidism and distinguish between primary and secondary thyroid pathologies.
- List the factors that influence normal growth.
- Diagram the control pathway for growth hormone release, including feedback signals and cellular mechanisms of action.
- Identify the hallmarks of hypersecretion and hyposecretion of growth hormone in children and adults.
- Distinguish between hypertrophy and hyperplasia.
- Describe the structure of bone and explain how bone is a dynamic tissue.
- Diagram the mechanisms by which bone adds diameter and length, including the cells and hormones involved.
- Explain the physiological functions of calcium.
- Diagram the distribution of calcium in the body and explain the factors that influence its movement between compartments.
- Diagram the endocrine control of plasma calcium concentration by parathyroid hormone and calcitonin, including the cellular mechanisms of action of each hormone.
- Describe the role of sex chromosomes in sex determination.
- Describe the bipotential reproductive structures of the early embryo.
- Diagram the processes of sexual differentiation in male and female embryonic development.
- Describe and compare male and female patterns of gametogenesis.
- Diagram the common hormonal control and feedback pathways for reproductive function.
- Explain the significance of pulsatile GnRH secretion.
- Describe some environmental factors that influence reproductive physiology.

- Diagram the internal and external anatomy of the adult male reproductive and accessory structures and give the function(s) of each.
- Diagram the process and timeline of spermatogenesis.
- Explain the hormonal control of spermatogenesis.
- Describe the primary and secondary sex characteristics of the male and the hormones that influence their development.
- Diagram the internal and external anatomy of the adult female reproductive and accessory structures and give the function(s) of each.
- Diagram and give the timeline for follicular development from primordial follicle to corpus albicans.
- Explain the role of atresia in ovarian function.
- Diagram the ovarian and uterine stages of the menstrual cycle.
- Relate the hormonal control and feedback patterns of the menstrual cycle to different stages of the ovarian and uterine cycles.
- Describe the secondary sex characteristics of the female and the hormones that influence their development.
- Diagram the erection reflex and describe the four phases of the human sexual response.
- Explain the anatomy or physiology of currently available contraceptive methods.
- Describe the common causes of male and female infertility.
- Diagram the process of sperm capacitation and fertilization of an ovum.
- Diagram the process of embryo development from fertilization through implantation in the endometrium.
- Describe the role of placental hormones during pregnancy.
- Describe what we currently understand about the processes of labor and parturition.
- Diagram a mammary gland and the control of milk and colostrum production.
- Diagram the let-down (milk ejection) reflex.
- Describe how the reproductive systems of males and females change at puberty and with menopause and andropause.

Deadline: Complete Modules 9 and 10 before the start of the tutorial.

*Deadline: Quiz 7 and 8 – **Wednesday August 18, 2021***

*Deadline: Quiz 9 and 10 – **Tuesday August 24, 2021** - this will give you an opportunity to review the answers to quiz prior to walking into the final exam.*