Physics 5210: Anatomy & Physiology

Course Syllabus and Objectives

Instructor: Tim Willett, MD MMEd

Contact: emailtotim@hotmail.com or 647-448-7119

Schedule

All sessions are Thursdays, 1:00-4:00 in Herzberg 3349.

12 Jan	Introduction; Anatomical terms; Regions & tissues
19 Jan	Anatomy and physiology: System-by-system
26 Jan	For this portion, each student will be assigned a system to present to their colleagues.
02 Feb	
09 Feb	Putting it together: Sectional and radiographic anatomy, region-by-region
16 Feb	(No class Feb 23)
02 Mar	Review and exam

Resources

Optional: Marieb, *Essentials of Human Anatomy & Physiology.* Benjamin Cummings. Get any edition – a used copy is fine!

Images

Dr. Willett will provide sets of anatomical and radiological images for use in the course.

Online resources

For your own self-study as well as for resources to help when presenting to each other, consider exploring the following sites for helpful items.

Zygote body browser: http://www.zygotebody.com/

MERLOT: www.merlot.org

MedEdPortal: www.mededportal.org

Neuroanatomy: http://www.atlasbrain.com/

The visible human project: http://vhp.med.umich.edu/tools2.html

Exam & Grading

There is no summative exam (i.e., an exam that determines a mark for this course). However, on the final day there will be a formative exam for you to test your own learning. We will go over the answers in class immediately following the exam. Participation is mandatory.

This course is graded as pass/fail. A pass grade requires:

1) Attendance at all classes;
2) Creation and delivery of a good quality presentation on the body system assigned to you; and
3) Completion of the final formative exam.

Academic Accommodations

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy Obligation:

Write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For accommodation regarding a formally-scheduled final exam, you must complete the Pregnancy Accommodation Form at https://carleton.ca/equity/accommodation/pregnancy-accommodation-form/ .

Religious Obligation:

Write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details see https://carleton.ca/equity/accommodation/religious-observances/ .

Academic Accommodations for Students with Disabilities:

The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website at https://carleton.ca/pmc/ for the deadline to request accommodations for the formally-scheduled exam (if applicable).

Survivors of Sexual Violence

As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: https://carleton.ca/equity/sexual-assault-support-services

Accommodation for Student Activities

Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation will be provided to students who compete or perform at the national or international level. Write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist: https://carleton.ca/senate/wp- content/uploads/Accommodation-for-Student-Activities-1.pdf

Learning Objectives

Part 1: Introduction

Tissues:

- List the four types of tissues
- Describe the components of an epithelium, state the general function of epithelia, and give 3 examples of epithelia and their specific functions
- State the two types of nervous tissues
- List the 4 classes of connective tissue
- Define cutaneous, mucous and serous membranes

Inflammation:

- Define inflammation
- State types of cells and processes involved in inflammation
- State changes that occur to tissues during inflammation

Anatomical terms – define:

- Cavities: Cranial, vertebral/spinal, thoracic, pleural, mediastinum, pericardial, abdominopelvic
- Position/direction: Superior/inferior; anterior/posterior; cranial/rostral/caudal; dorsal/ventral; distal/proximal; medial/median/lateral; deep/superficial
- Planes: Coronal/frontal, sagittal and axial/transverse/horizontal
- Regions: Cephalic, frontal, orbital, mental, occipital, cervical, thoracic, mammary, abdominal, lumbar, sacral, pelvic, inguinal, pubic, axillary, brachial, carpal, palmar, femoral, popliteal, tarsal, pedal, plantar

Prefixes and Suffixes – define:

- Prefixes: ad-, adeno-, af-, anastom-, angio-, ante-, arthro-, athero-, auto-, brachi-, broncho-, carcin-, cardi-, cephal-, cerebro-, chrondr-, circum-, contra-, cort-, cost-, crani-, cyst-, dent-, derm-, dors-, dys-, ef-, enceph-, endo-, entero-, exo-, extra-, foram-, gastr-, gono-, hema/hemo-, hemi-, hepat-, hiat-, hyper-, hypo-, hyster-, infra-, inter-, intra-, juxta-, lipo-, mamm-, mast-, medull-, meta-, myo-, nephro-, neuro-, oculo-, oo-, ophthalmo-, orchi-, ortho-, osteo-, oto-, para-, peri-, phleb-, pleur-, pod-, post-, pre-, procto-, pulmo-, rect-, retro-, rhin-, semi-, sub-, super-, supra-, trans-, viscer-
- Suffixes: -algia, -carcinoma, -dynia, -ectomy, -gram, -graph, -itis, -lumen, -lysis, -oid, -oma, -otomy, -plasia, -plasty, -rrhagia, -sarcoma, -scope, -stomy, -tomy, -trophy

Part 2: Gross Anatomy and Essential Physiology

Musculoskeletal (1 hour)

State the location and describe the listed features of the major bones of the body:

- Skull: Number of bones (**not** specific names) and fused nature; temporomandibular joint; foramen magnum; sinuses (frontal, ethmoid, sphenoid, maxillary).
- Vertebrae: Number at each level; body, vertebral arch, spinous and transverse processes, vertebral foramen, intervertebral foramen, intervertebral disc (including tissue composition). What is a disc herniation? How can it affect the spinal cord and nerves?
- Thorax: Number and orientation of ribs, articulation with vertebrae; costal cartilages, sternum.
- Upper limb: Clavicle, scapula, humerus, radius, ulna, number and general layout of carpal bones, metacarpals, phalanges. How is the upper limb attached to the axial skeleton? What are the advantages of this configuration?
- Lower limb: Pelvis (3 bones), sacroiliac joint, obturator foramen, pelvic floor (location – not details of muscles), acetabulum, femur, patella, tibia, fibula, ankle joint (bones involved and configuration), tarsal bones (number and general configuration; only point out the calcaneus specifically), metatarsals, phalanges.

Ligaments and cartilage: As an exemplar, the knee joint: Collateral ligaments, cruciate ligaments, condyles, menisci. What is the function of each of these?

What is the difference between osteoarthritis and rheumatoid arthritis? What effect does arthritis have on a joint?

Briefly describe how a bone heals when injured.

State the general structure of a skeletal muscle: Body, origin, insertion, fasciae. What is a tendon? What is an aponeurosis? How does a muscle contract and what is the role of actin and myosin?

Respiratory (1 hour)

Describe the location of each of the following structures of the airway:

- Upper airway: Nasal cavity, oral cavity, hard palate, soft palate, pharynx, larynx, thyroid cartilage, cricoid cartilage, epiglottis, vocal cords (false and true).
- Lower airway: Trachea, carina, main stem bronchi. Describe the differences between a bronchus, bronchiole, alveolar duct and alveolus. Describe the microscopic structure of an alveolus.
- Gas exchange: How do O2 and CO2 get in and out of the body? How does the way the blood transports O2 differ from the way it transports CO2? What is the relationship between CO2 and blood acidity? How does chronic obstructive pulmonary disease (COPD) affect airways and alveoli? How does pneumonia affect alveoli? What is a shunt?

State the general structure of the pleura. What is its purpose? What happens when air gets into the pleura? What happens when fluid gets in?

Thorax: Upper and lower boundaries, diaphragm. How does the shape of the thorax change as we breathe? What causes air to be inhaled? Exhaled?

Lungs: Lobes and fissures. Pulmonary arteries, capillaries and veins. What is a pulmonary embolus and how does it affect the lungs? How can a tumour affect the lungs?

Gastrointestinal (1 hour)

Describe the location and summarize the functions of the following structures:

- Peritoneum.
- Upper GI tract: Mouth, salivary glands (3), pharynx, esophagus, stomach (and 2 sphincters). How does swallowing work? What is heartburn?
- Lower GI tract: Duodenum, jejunum, ileum, colon, appendix, rectum, anus. Mesentery and omentum. How is the proximal small intestine different from the distal small intestine? How is food moved through the intestines?
- Hepatobiliary: Liver (including the hepatic artery and portal vein); hepatic duct, gallbladder, cystic duct, bile duct; pancreas, pancreatic duct. Why does the liver receive blood from two sources (the hepatic artery and portal vein)? What is the function of the gallbladder? What is the function of the pancreas (focus on exocrine function only)?

What happens if there is a blockage of the intestines? How does colon cancer arise?

What happens to the liver in cirrhosis? What are gall stones and what happens if they block the cystic duct? Why can a tumour in the area of the duodenum or pancreas cause so many complications?

Urinary (1 hour)

Describe the location and summarize the functions of the following structures.

Kidneys:

- Gross anatomy: Location and relation to ribs. Cortex, medulla, pyramids, pelvis.
- Microscopic anatomy (nephron): Glomerulus, proximal convoluted tubule, loop of Henle, distal convoluted tubule, collecting duct. Why does the kidney contain two sets of capillaries?
- Define filtration, reabsorption and secretion. Where does each occur?

The urinary tract:

- Ureters, urinary bladder (detrusor muscle, trigone, neck), urethra, internal and external sphincters. Compare male and female anatomy.

What is the glomerular filtration rate? How does the kidney control urine concentration (and thereby control body water)?

What is acute kidney injury (acute renal failure) and chronic kidney disease (chronic renal failure)?

What effects can radiological dyes and contrasts have on the kidneys?

Reproductive (1 hour)

Describe the location and summarize the functions of the following structures.

- Male: Scrotum, testes, epididymis, ductus deferens (vas deferens), inguinal canal, seminal vesicles, prostate, penis.
- Female: Ovaries, fimbriae, fallopian tubes, uterus (myometrium, endometrium), cervix, vagina. What is a primary follicle, secondary follicle, vesicular (Graafian) follicle, and corpus luteum?

- Breast: Lobes, lactiferous ducts and sinuses.
- Obstetrics: Placenta (gross and brief description of microscopic), umbilical arteries and vein, amniotic sac.

What is an inguinal hernia? What is benign prostatic hypertrophy? Where can a prostate tumour invade?

What is an ovarian cyst? What is a teratoma? Where can an ovarian tumour invade? Where can a cervical tumour invade?

Circulation – The Heart (1 hour)

Describe the location and summarize the functions of the following structures.

- Pericardium, myocardium, endocardium. How is cardiac muscle different than skeletal muscle?
- Chambers and valves: Right atrium, tricuspid valve, right ventricle, pulmonic valve, left atrium, mitral valve, left ventricle, aortic valve. Interatrial septum, interventricular septum, apex. Papillary muscles and chordae tendinae. Where is each chamber positioned when looking at the thorax from the anterior?
- The cardiac cycle: SA and AV nodes, pathway and sequence of excitation/contraction. Define systole, diastole, stroke volume, contractility. What is the Frank-Starling law? What three factors determine stroke volume? What is cardiac output? Describe the formula CO = SV x HR. What is a normal cardiac output for humans?
- Coronary circulation: Origin of the coronary arteries, left coronary artery, anterior interventricular artery, circumflex artery, right coronary artery, posterior interventricular artery. How do the capillaries course through the cardiac muscle? What factors determine cardiac perfusion?

What is meant by prolapse (regurgitation) and stenosis of the heart valves?

What is myocardial ischemia? What is a myocardial infarction?

Circulation – Blood Vessels (1 hour)

Vessel structure and function:

- Compare and contrast the structure of arteries, arterioles, capillaries, venules and veins. What roles do each of these play in circulation?
- Define systolic and diastolic pressure. How do arteries maintain blood pressure? Define peripheral vascular resistance. What factors determine blood pressure (explain the relationship BP α CO x PVR)? What factors determine perfusion to a given capillary bed?
- Define atherosclerosis and summarize the process of plaque formation. What effect does atherosclerosis have on blood pressure? How does atherosclerosis lead to arterial blockage and tissue infarction?
- What is an aneurysm and what risks do they pose?

The great vessels: Describe the anatomy of the following vessels:

- Arteries: Aorta (ascending, arch, descending); brachiocephalic trunk, common, internal and external carotid arteries; subclavian, axillary, brachial, ulnar and radial arteries; celiac trunk,

superior and inferior mesenteric arteries; renal arteries; common, external and internal iliac arteries; femoral artery.
- Veins: superior and inferior vena cava.
- Pulmonary circulation: Pulmonary trunk, pulmonary arteries, lobar arteries, pulmonary veins.

Lymphatics (30 min)

The lymphatic and immune systems are complex, particularly at the cellular and biochemical levels. Focus on the anatomy with a brief overview of function.

Lymphatics:

- General structure of lymphatic vessels and lymph nodes.
- Brief overview of locations of lymph node clusters.
- Right lymphatic duct and thoracic duct (and body areas drained by each).
- Spleen, thymus and tonsils.
- What happens when a lymphatic vessel becomes obstructed?

Immunity (basic only!):

- Barriers: Skin and mucosae.
- Non-specific defenses: Macrophages, neutrophils, natural killer cells, complement system.
- Specific (adaptive) defences: Antigens and antibodies, B lymphocytes and plasma cells, T lymphocytes (3 types).
- What is immunodeficiency? Autoimmune disease? Hypersensitivity?

Endocrine (30 min)

The endocrine system, with all the hormones and regulatory controls, is also complex. For this course, focus on anatomy with a brief overview of function.

Describe the anatomy and summarize the function of the following:

- Thyroid and parathyroid glands.
- Hypothalamus and pituitary gland.
- Pineal gland.
- Adrenal glands.
- Endocrine pancreas.
- Gonads.

Nervous (1 hour)

Define the following terms: Central nervous system, peripheral nervous system, autonomic nervous system (sympathetic and parasympathetic), neuron, afferent, efferent, neuroglia, white matter, grey matter, nucleus, ganglion.

Nerves and supporting cells:

- Briefly describe the structure of a neuron.
- Describe the structure and roles of oligodentrocytes and Schwann cells. What is myelin? What is saltatory conduction? How does multiple sclerosis affect the nervous system?

- Describe a simple neurological circuit, such as an afferent neuron entering the spinal cord, synapse with an interneuron, synapse with an efferent neuron that leaves the spinal cord.

The brain:

- Meninges: Dura, arachnoid and pia. Subarachnoid space. Epidural space.
- Cerebrum: Frontal, parietal, occipital and temporal lobes; central sulcus, precentral and postcentral gyrus; lateral fissure; corpus callosum; basal ganglia (caudate, putamen, globus pallidus); internal capsule; hippocampus.
- Ventricles: Lateral, third, fourth, cerebral aqueduct, and central canal; choroid plexus; describe the flow of cerebrospinal fluid. What happens if this flow is obstructed?
- What is the limbic system and what functions is it responsible for (generally; no specific anatomy)?
- Identify major regions of the cerebrum associated with: Movement, tactile sensation, cognition, emotion, sensory association, vision, audition, olfaction, memory, language (Wernicke and Broca areas). What is the homunculus?
- What problems can a brain tumour cause?

Brainstem:

- Thalamus, midbrain (cerebral peduncles, superior and inferior colliculi), pons, medulla (pyramids and olives), cerebellum (hemispheres, vermis, flocculi).
- What types of functions are served by the brainstem? By the cerebellum?

Spinal cord:

- General cross-sectional structure (white and grey matter, anterior and posterior horns, central canal, ventral and dorsal nerve roots, spinal nerve).
- Conus medullaris, cauda equina and lumbar cistern.

Pathways: There are dozens of identified neural pathways within the central nervous system. In order to understand the impact of certain diseases or injuries, it helps to understand a few key pathways. For each of these pathways, briefly summarize the information that is carried, and the course of the tracts (start, synapses and decussations, termination):

- Anterolateral system
- Dorsal column / medial lemniscus
- Corticospinal (pyramidal)

Blood supply:

- Arteries: Internal carotid; vertebral; circle of Willis; anterior, middle and posterior cerebral arteries.
- What is an epidural or subarachnoid hemorrhage?
- What is a stroke? What are the two kinds of stroke? What is a transient ischemic attack?

Autonomic:

- What are the roles of the sympathetic and parasympathetic systems?

Cancer (30 min)

Keep the focus on the aspects of cancer that relate to anatomy and radiography.

- Define: Tumour, neoplasm, cancer, hyperplasia, metaplasia, dysplasia, apoptosis.
- Compare features of benign vs. malignant neoplasms.
- Summarize the process of oncogenesis (basic only – don't get into the genetic mechanisms). What are proto-oncogenes, tumour suppressor genes, and the two-hit hypothesis? What is meant by initiation, promotion and progression?
- What does a tumour require in order to continue to grow and survive? What is invasion? Give examples of local consequences of tumour growth (i.e. impacts on the surrounding tissues and organs).
- What does a tumour require in order to metastasize? What are common routes of metastasis?
- Review the types of tissue from which cancer may arise and give some examples of benign and malignant growth from each.
- Briefly summarize approaches to cancer treatment: Surgery, radiotherapy, chemotherapy, hormonal therapy, and immunotherapy. How and why do each work?

Part 3: Sectional and Radiologic Anatomy

The final part of the course (2 sessions) will involve revisiting the same anatomy as described above, but in x-rays, sections (e.g. CT and MRI) and specialized radiological studies. Dr. Willett will lead these sessions.

Academic Integrity

Academic misconduct undermines the values of honesty, trust, respect, fairness, and responsibility that we expect in this class. Carleton University provides supports such as academic integrity workshops to ensure, as far as possible, that all students understand the norms and standards of academic integrity that we expect you to uphold. Your teaching team has a responsibility to ensure that their application of the Academic Integrity Policy upholds the university's collective commitments to fairness, equity, and integrity (adapted from Carleton University's Academic Integrity Policy, 2021).

Examples of actions that do not adhere to Carleton's Academic Integrity Policy include:

- Plagiarism
- Accessing unauthorized sites for assignments or tests
- Unauthorized collaboration on assignment and exam

Sanctions for not abiding by Carleton's Academic Integrity Policy

A student who has not adhered to Carleton's Academic Integrity Policy may be subject to one of several sanctions:

1. If you take full responsibility for your actions, and it is the first time you have violated the policy, you will receive zero on the assessment. If you are found to have violated the policy but do not take responsibility, an additional grade deduction will be applied (e.g. an A- will become a B+)

2. Subsequent violations of the policy may result in more severe sanctions such as failing the course, suspension from all studies and/or expulsion.

Process of an Academic Misconduct Investigation

Step 1: The instructor believes misconduct has occurred and submits documentation to the Dean of the Faculty of Science.

Step 2: The Dean reviews documentation and can proceed with or dismiss the allegation.

Step 3: If sufficient evidence, the student receives an allegation statement by email. Ombuds services is copied on the email.

Step 4: The student provides a written response to the evidence provided.

Step 5: Either party may request a meeting between student, dean, and the ombudsperson.

Step 6: Dean informs the student of the decision.

Appeal: Student has the right to appeal the decision.

Additional details about this process can be found on the Faculty of Science Academic Integrity website. Students are expected to familiarize themselves with and follow the Carleton University Student Academic Integrity Policy. The Policy is strictly enforced and is binding on all students.

Plagiarism

Plagiarism is the passing off of someone else's work as your own and is a serious academic offence. For the details of what constitutes plagiarism, refer the Faculty of Science Academic Integrity website. To further understand Academic Integrity, consider attending the Learning and Support Academic Integrity Workshop. Summer 2022 14

What are the Penalties for Plagiarism? A student found to have plagiarized an assignment may be subject to one of several penalties including: expulsion; suspension from all studies at Carleton; suspension from fulltime studies; and/or a reprimand; a refusal of permission to continue or to register in a specific degree program; academic probation; award of an FNS, Fail, or an ABS.

What are the Procedures?

1. All allegations of plagiarism are reported to the Dean of Faculty of Science. Documentation is prepared by instructors and/or departmental chairs.

2. The Dean writes to the student and the University Ombudsperson about the alleged plagiarism.

3. The Dean reviews the allegation. If it is not resolved at this level then it is referred to a tribunal appointed by the Senate.

Students are expected to familiarize themselves with and follow the Carleton University Student Academic Integrity Policy. The Policy is strictly enforced and is binding on all students. https://carleton.ca/registrar/academic-integrity/

Assistance for Students

Academic and Career Development Services: http://carleton.ca/sacds/

Writing Services: http://www.carleton.ca/csas/writing-services/

Peer Assisted Study Sessions (PASS): https://carleton.ca/csas/group-support/pass/

Math Tutorial Centre: https://carleton.ca/math/math-tutorial-centre/

Science Student Success Centre: https://sssc.carleton.ca/

Special Information for Pandemic Measures

Carleton will continue to follow all public health guidelines as the COVID-19 pandemic continues. Instructors may find it helpful to review the guidelines for in-class teaching and labs. Both guideline documents are available on the COVID-19 website at https://carleton.ca/covid19/safe-return-to-campus/classroom-guidelines/ .

It is important to remember that COVID is still present in Ottawa. The situation can change at any time and the risks of new variants and outbreaks are very real. There are a number of actions you can take to lower your risk and the risk you pose to those around you including being vaccinated, wearing a mask, staying home when you're sick, washing your hands and maintaining proper respiratory and cough etiquette. See https://carleton.ca/covid19/health-and-safety/reducing-your-risks/

Feeling sick? Remaining vigilant and not attending work or school when sick or with symptoms is critically important. If you feel ill or exhibit COVID-19 symptoms do not come to class or campus. If you feel ill or exhibit symptoms while on campus or in class, please leave campus immediately. In all situations, you must follow Carleton's symptom reporting protocols – see https://carleton.ca/covid19/covid-19-symptom-reporting/ .

Masks: Carleton has paused the COVID-19 Mask Policy (see https://carleton.ca/covid19/policies-and-protocols/mask-policy/), but continues to strongly recommend masking when indoors, particularly if physical distancing cannot be maintained. It may become necessary to quickly reinstate the mask requirement if pandemic circumstances were to change.

Vaccines: Further, while proof of vaccination is no longer required as of May 1 to attend campus or in-person activity, it may become necessary for the University to bring back proof of vaccination requirements on short notice if the situation and public health advice changes. Students are strongly encouraged to get a full course of vaccination, including booster doses as soon as they are eligible, and submit their booster dose information in cuScreen (via http://carleton.ca/covid19/cuscreen) as soon as possible. Please note that Carleton cannot guarantee that it will be able to offer virtual or hybrid learning options for those who are unable to attend the campus.

All members of the Carleton community are required to follow requirements and guidelines regarding health and safety which may change from time to time. For the most recent information about Carleton's COVID-19 response and health and safety requirements please see the University's COVID-19 website at https://carleton.ca/covid19/ and review the Frequently Asked Questions (FAQs) at https://carleton.ca/covid19/faq/. Should you have additional questions after reviewing, please contact covidinfo@carleton.ca.

Important Dates for 2022-23

A full list of important dates is available on the Calendar website. Please note that the academic withdrawal dates have changed recently. Consult the Calendar website for the most updated information: https://calendar.carleton.ca/academicyear