BIOLOGY 3251 WA 2024
PROPOSED COURSE OUTLINE
Animal Physiology - Organ System Operation and Regulation
Instructor: Dr. Robert J. Omeljaniuk, CB-4013

1. Calendar Description.

Animal Physiology - Organ System Operation and Regulation
0-0; 3-3
A comparative study of animal organ system physiology. Areas to be discussed include the structure, operation and regulation of muscle, cardiovascular systems, osmotic and ionic regulation, respiratory- and gastrointestinal systems.
Notes: *Students who have previous credit in Biology 2035 may not take Biology 3250 or 3251 or 3253 for credit. An additional fee (see Miscellaneous Fees) is required for this course.*

2. Tentative Marking Scheme.

a. Laboratory exercises and lab reports:
Two formal lab reports will be submitted for each of the labs performed. Mark resolution for each lab report is
(1) Results: 3 Final Marks; and
(2) Discussion: 7 Final Marks.

Formal lab report assignments to be announced.

b. Term Tests:
Term tests will take place in lab periods in order to offer the maximum amount of time for students to respond to questions
(1) Term test #01. 01 Mar 2024. 30% Final Mark; and
(2) Term test #02. 03 Apr 2024. 30% Final Mark.

c. Renal Physiology Essays:

The purpose of term papers is to provide students with exposure to known concepts of mammalian renal function in a directed study paradigm. Students will submit essays on the following topics using the course textbook as their primary reference.

(1) Detailed consideration of the gross anatomy and histology of the mammalian kidney with emphasis on a detailed evaluation of the filtration apparatus and the renal tubule.
10% Final Mark, Due in class 05 February 2024.

(2) Detailed consideration of renal filtration, as well as reabsorption and secretion processes within the renal tubule.

10% Final Mark, Due in class 04 March 2024.

Essay narrative shall not exceed 12 pages double-spaced (and single sided). Figures and tables shall be presented in a professional manner as attributed extractions from the course textbook accompanied by associated captions (professional grade reproductions of textbook figures and tables are acceptable and recommended).

Manuscripts shall conform to the Instructions to Authors for manuscript submission as defined by The Canadian Journal of Zoology (CJZ).

Any submission which is inconsistent with the CJZ instructions will be returned unmarked and attributed a score of zero.

3. Laboratories.

a. Lab coordinator: Mr. Michael Moore, CB-3011A; 343-8909.

b. Schedule:

Lab schedule and lab report submission dates are subject to change in accordance with availability of animal preparations and instrumentation.

c. Lab Reports.

(1) Due as indicated in laboratory schedule;
(2) Late reports will not be accepted without medical or compassionate explanations.
(3) Reports will be marked and returned as soon as possible.
(4) Format. Neatly written, typed, or word-processed **according to the manuscript requirements (Instructions to Authors) for Canadian Journal of Zoology**.
(5) Illegible reports will not be accepted; plagiarism, to any extent, will not be accepted.
(6) The textbook is the primary reference for lab reports. Websites are not authorized as references although peer-reviewed journals accessible on the internet are authorized and are to be appropriately cited in accordance with CJZ instructions.
(7) **Any submission which is inconsistent with the CJZ instructions will be returned unmarked and attributed a score of zero.**
(8) Report Marks.

(a) Introduction: Provides the scientific basis for the work performed: Pass/Fail. Failure results in Report returned, not marked, for a score of 0.0 Final Marks.
(b) Results: Drafted figures, tables and a textual summary of experimental findings: 3.0 Final Marks.

(c) Discussion: Discussion of the scientific basis and biological relevance of the data, and comparison of the results with published findings; this section also includes appropriate presentation of cited references; 7 Final Marks. **PAGE LIMIT OF 6 PAGES; OVERLENGTH DISCUSSIONS WILL BE REJECTED *in toto*. This page limit is quite tight; you will have to produce a very condensed Discussion section.**

ADVICE. Formal reports require significant effort for data presentation, reading and interpreting reference material, and incorporating relevant reference material into meaningful discussions.

4, Proposed curriculum: See attached pages.

5. Textbooks:

a. Boron, W.F. and E.L. Boulpaep. Medical Physiology, 3rd ed. Saunders, Philadelphia PA.; and

b. Biology 3251 Lab Manual. Available as part of the Comparative Animal Physiology I & II Lab Manual in the LU Alumni Bookstore.

Proposed Curriculum

1. READING ASSIGNMENT.

a. There is a requirement for you to have an understanding and firm grasp of the aspects of renal physiology. As renal physiology is typically considered toward the end of the course and that lecture progress may prohibit my actually lecturing on this subject in depth you are required to independently (or collaboratively) review the material in

(1) Chapter 33. Organization of the urinary system;
(2) Chapter 34. Glomerular filtration and renal blood flow;
(3) Chapter 35. Transport of sodium and chloride;
(4) Chapter 36. Transport of urea, glucose, phosphate, calcium, magnesium, and organic solutes;
(5) Chapter 37. Transport of potassium;
(6) Chapter 38. Urine concentration and dilution;
(7) Chapter 39. Transport of acids and bases; and
(8) Chapter 40. Integration of salt and water balance.

b. Now, pay attention! There is too much material in these chapters to actually acquire an expert knowledge of it in the time allotted. Moreover, much of it is clinical (human) in its' focus. So, extract what is necessary from these chapters in order to be able to lucidly, and in detail, describe and discuss

(1) The gross (a) anatomy, (b) histology and (c) cytology of the kidney;
(2) The (a) structures, (b) forces and (c) regulation of filtration at the renal corpuscle without discussing the calculation of renal clearance rates;
(3) The cells, structures and mechanisms of reabsorption (and secretion where appropriate) of

(a) Na^{+};
(b) K^{+};
(c) Ca^{++};
(d) Cl^{-};
(e) HCO_3^{-} and CO_3^{--};
(f) the phosphate anions; and
(g) glucose.

(4) Management and utility of urea; and
(5) The role of the kidney in regulating blood pH.

c. Task execution

(1) This is a parcel of material that is very large to consider in a very brief period of time. You should consider as a class to subdivide the task responsibly and consolidate your efforts in the intelligence analysis

phase. You are individually responsible for your knowledge of this material.

I. MUSCLE PHYSIOLOGY

1. Muscle physiology general references.

2. Comparative organization and anatomy of

   a. Skeletal (striated) muscles and cells.

   b. Smooth muscles and cells.

   c. Cardiac muscles and cells.

3. Vertebrate skeletal muscle.

   a. Cell microanatomy;
   b. Molecular organization of contractile filaments: actin and myosin filaments; and
   c. Organization of: T-tubules, sarcoplasmic reticulum, terminal cisternae.

4. Regulation of skeletal muscle.

   a. Innervation by
      (1) voluntary paths-role of motor cortex; and
      (2) involuntary paths-spinal reflex arcs.

   b . Comparison of multiterminal and polyneuronal innervation.

   c . Motor end plate
      (1) morphology;
      (2) physiology-electrical events, neurochemical events, receptor events; and
      (3) pharmacology.

   d. Excitation:contraction coupling.

   e. Sliding filament theory of muscle contraction: power stroke, recovery stroke, ionic and non-ionic mechanisms.

f. Neural and mechanical components of graded muscle contraction: clonus, tetany, facilitation.

g. Isometric and isotonic contraction: contractile component, series elastic component, parallel elastic component.

h. Relationship of lead (stretch) to form of contraction.

i. Energy transformations in muscle: ATP, phosphogens, glucose, glycogen.

j. Comparative anatomy and physiology of skeletal muscle.

5. Vertebrate smooth muscle.

a. Cell microanatomy and molucular organization of contractile filaments;
b. Organization of smooth muscle cells: visceral smooth muscle vs multiunit smooth muscle;
c. Regulation of smooth muscle contraction; and
d. Molecular basis of smooth muscle contraction.

6. Vertebrate cardiac muscle.

a. Cell microanatomy and molecular organization of contractile filaments;
b. Electrical properties of cardiac myocytes;
c. Molecular basis of cardiac myocyte contraction; and
d. Comparative anatomy and physiology of cardiac muscles: neurogenic vs myogenic hearts.

II. CIRCULATORY PHYSIOLOGY

1. Vertebrate heart.

a. Anatomy;
b. Electrical functions; and
c. Regulation of heart function: neural, endocrine, mechanical mechanisms.

2. Blood vessels.

3. Overview of vascular system: pathway of blood flow, structure of blood vessels, compartment volumes.

4. Capillaries.
    a. Structure;
    b. Exchange mechanisms: diffusion, pinocytosis, diapedesis, ultrafiltration;
    c. Ultrafiltration-mechanical basis; and
    d. Regulation.

5. Lymphatic system.

    a. Gross organization;
    b. Cellular organization; and
    c. Function: uptake and movement of lymph, filtration of extracellular fluid, fat absorbtion from intestine.

6. Arterial system.

    a. Elastic arteries;

    b. Muscular arteries and arterioles;

    c Regulation of blood flow: resistance, vasoconstriction, vasodilation; and

    d. Regulation of vasoconstriction.

        (1) direct: myogenic response, autoregulation, local regulators of blood flow;and

        (2) indirect: neural (afferent paths, efferent paths), endocrine paths.

7. Venous system.

8. Regulation of heart productivity.

    a. Stroke rate: vagus, sympathetic, endocrine; and
    b. Stroke volume: Frank-Starling law, myocardial contractility, stroke rate, training.

III. <u>RESPIRATION. GAS-EXCHANGE AND BLOOD pH REGULATION</u>

1. References (TBA).
2. Introduction-solubility of 0_2, $C0_2$.
3. Respiratory pigments.

    a. Oxygen and hemoglobin (Hb).

(1) Hb-structure and function;
(2) Bohr effect, Haldane effect;
(3) Phylogenic variation; and
(4) Relationship between 0_2 tension and Hb:0_2 interaction.

b. $C0_2$ transport.

(1) Bicarbonate;

(2) Carbamino compounds; and

(3) Transfer of $C0_2$ between blood and tissues.

4. Regulation of pH.

a. H^+-production and excretion; and
b. Involvement of $C0_2$ and bicarbonate.

5. Special Topic: Respiration and high-altitude physiology.

FOR WA 2024 THE LECTURE CURRICULUM MAY STOP HERE

IV. EXCRETION AND OSMOREGULATION

1. References. (TBA)

2. Metabolic wastes.
Phylogenic organization of nitrogenous waste excretors: ammonioteles, ureoteles, uricoteles, guanoteles.

3 Gross morphology of mammalian kidney.

4. Nephron anatomy.

5. Filtration, reabsorbtion, secretion.

6. Endocrine regulation of nephron function. Participation of kidney in blood pH regulation. and if time permits.

VI. GASTROINTESTINAL PHYSIOLOGY

1. References. (TBA)

2. Detailed examination of structure and innervation of the mammalian gut.

3. Histology and cytochemistry of secretory cells and their products.

4. Neural and endocrine regulatory mechanisms for regulation of exocrine and endocrine gut secretions.

5. Liver structure, functions, and cytochemistry-biochemistry and regulatory mechanisms associated with bile production.

6. Water and electrolyte balance in the gut.