

Biology 335, Fall 2014

Principles of Physiology

General Course Goals:

1. You will learn a lot of new vocabulary.
2. You will relate the new vocabulary to a series of concepts used by physiologists.
3. You will learn the general concepts and hypothesis describing and constraining how physiological systems work.

Required Textbooks (Available at the Bookstore):

- Koeppen, B.M. and B.A. Stanton 2008 (6th Edition). Berne & Levy Physiology. Mosby Year Book. 834pps.
- Laboratory Manual: Principles of Physiology Laboratory Manual(Blackboard, Lab- oratory Module)

Reference Texts (not required but sufficiently interesting to be aware of!):

- Boron, W.F. and E.L. Boulpaep. 2009. Medical Physiology A Cellular and Molec- ular Approach. 2nd ed. Saunders Elsevier, Philadelphia, Pa. 1337pps.
- Greger R. and U. Windhorst. 1996. Comprehensive Human Physiology. Volume I and II. Springer Verlag, NY.
- Lyn, Shauna. 2004. Lange Smart Charts Physiology. Lange Medical Books, NY.
- Hall, J.E., and A.C. Guyton. 2011. Guyton and Hall Textbook of Medical Physiology. Saunders. NY. 1091pps

Concept Mapping Software

Free

- Sdraw (Open Office Suite, (<http://download.openoffice.org/index.html>))
 - Cmap Tools (<http://cmap.ihmc.us/>)
 - Freemind ([http://freemind.sourceforge.net/wiki/index.php/Main Page](http://freemind.sourceforge.net/wiki/index.php/Main_Page))
- Commercial
- Inspiration (<http://www.inspiration.com/productinfo/inspiration/index.cfm>)

We will discuss why you might need software in lab. These are all good software packages, each does something a little bit different from the other.

Course Information Center: The course is registered as a Blackboard course. Make sure that you can find it and that you are enrolled. We can communicate through Blackboard, but this is limited to Blackboard email which is a different system than our regular ISU email. I would strongly recommend using the regular campus email system. Please type Biol335 into your subject line to help me find incoming email.

All necessary files including this syllabus can be down loaded from the Blackboard site as pdf files which can be read and printed with Adobe Reader or Adobe Acrobat. They will also come up in your web browser, if it is configured properly.

All of the lecture and lab materials (figures, instruction, syllabi) are available via Black- board. Look under the left menu button, Learning Modules, and you will see a variety of sequentially numbered modules, each module covers a particular area of information. We will begin with Module 1 and progress through Module 7. The Laboratory Module will contain the Lab Manual and all data that are available through the lab. All of the figures used in the lectures can be downloaded as pdf files either as 1 figure per page or 4 figures per page.

Testing and Grading Procedures:

Possible Points:

Type	Value
Blackboard Final	60
Blackboard Module Exams (6 x 30 pts)	180
Attendance (Clickers) (25 pts)	25
Lab	
Labs 2-14 (13 x 18 pts)	
Presentations, Lab 15 (1 x 30 pts)	60
Total	519

There are 519 pts possible in the course, with 265 from the lecture and 274 from the laboratory. Plus and minus grading will be used. The Blackboard exams (including the final) will consist of a number of multiple choice, true-false, short answer or similar type questions. Questions drawn from the lecture, the textbook, as well as laboratory materials (especially the cases and problems) may appear. The (Blackboard) final exam will be given during finals week, using the same format as the semester exams. The first 30 pts of the final exam will cover the material since the last Blackboard exam. The 2nd 30 pts will be a comprehensive exam of the lecture material presented during the entire semester. Once again, the exam format (for any exam) may include:

- short answer type questions
- graphical material to interpret
- true or false questions
- multiple choice questions

Any equations that you might need will be given to you. You will not be expected to derive any mathematical model. The (in-semester) Blackboard exams will be given about every 2 weeks beginning in the 3rd week and will cover all preceding material but will focus on the material covered since the last exam, with the exception of the first exam, of course. You may take the exam at any time during the week it is offered but you may only take the exam once. You will take the exam at the testing center (2 on campus). You may take pen and clean paper with you but nothing else. Once you open the exam, it will remain open for 60 minutes and will then close. The exam will open on a Friday and will be closed at 2400 hrs the next Friday. If you do not complete the submission, you do not get credit. When you submit you should be notified. If something goes awry, Contact me as soon as possible by email. Often, I can submit the exam for you if it has hung. The lab is worth 274 pts. See the lab syllabus for lab grading procedures.

Makeups for the exams are by arrangement and should be arranged prior to the exam that you are going to miss. It is better to anticipate problems and see me in advance, especially if you have any questions. If for some reason you feel unable to take or complete a lab you should see the lab instructor in advance of the lab. If you have special needs for taking these kind of exams, please see me at the beginning of the semester. The syllabus available via Blackboard is the official syllabus; it may be revised from time to time, pay attention to the date. If you have any issues or accommodations that I should be aware of, please see me as soon as possible.

Tentative Blackboard Exam Schedule

#	Week of	Points
1	8 September	30
2	22 September	30
3	6 Oct	30
4	20 Oct	30
5	3 Nov	30
6	17 Nov	30

Classroom Behavior

- . Arrive in the classroom on time.
- . Turn off cell phones prior to class.
- . Turn off iPods and similar equipment prior to class—remind the instructor to turn off his.
- . Pay attention in class.
- . Ask questions if something makes no sense or if you want further explanation on any point of information.
- . If you need to leave early please sit near a door and, it never hurts to inform the instructor. Laboratory Consultation and Office Visits

Guide to general course objectives by module and study guide. You should be able to answer these questions both in general and to the level of detail described in lecture.

Course Objectives and Study Guide

• Module 1 Important concepts

– What is a model?– What does it mean to falsify a prediction?– What is Reductive Knowledge?– What Integrative Knowledge?– What kinds of Models can be built?– What is a balance model?– What is physiological regulation?– What is Transport?– What is the difference between a channel and a transporter?

• Module 2

Membrane Potentials

- What is an ionic Equilibrium?
 - What is a charge equilibrium?
 - What is osmotic equilibrium?
 - What are concentration and charge balances?
 - What is the Nernst Model (Equation)?
 - What is a Donnan Equilibrium (Model)?
 - What are current equations (Models)?
 - What is a membrane potential?

Action Potentials

- What is an excitable membrane?
- What is an action potential?
- How is an action potential generated?
- What are the characteristics of an action potential?
- How does an action potential propagate?
- What is the relationship between sodium or potassium conductances and the action potential?
- What is a conductance? Synaptic Transmission
- What is a synapse?
- How many kinds of synapse are there?
- What is a chemical synapse?
- What is a neurotransmitter and how many types are there?
- Where does the neurotransmitter come from and where does it go to?
- In general, how does a chemical synapse work?
- What is spatial summation?
- What is temporal summation? Cellular Signalling
- What does cellular signalling usually mean?
- What is intracellular signalling?
- What role do receptors play in cellular/intracellular signalling?
- What is a first messenger?
- What is a second messenger?
- What is a signal transduction pathway?
- What are the differences among Neurocrine, Endocrine, Paracrine, Autocrine and Contact-dependent signalling systems?

• Module 3 Muscle

- Describe the relations between structure and function for muscle.

- Describe the Sliding Filament Theory for muscle contraction.
- What is meant by muscle mechanics?
- Describe how reflex control might be involved in the control of muscle contraction.
- How is smooth muscle different from skeletal muscle?
- What are the differences between single-unit and multi-unit smooth muscle?
- What is the difference between myosin regulation vs actin regulation?
- What is a latch state?

• Module 4 Cardiovascular

The Cardiovascular System

- How are CV structure and function related?
- What force causes blood to flow around the CV system?
- What is Poiseuille's Law (model)?
- How does the cardiac pump work?
- What are preload and afterload?
- How is a cardiac PV curve interesting?
- What is the cardiac cycle?
- What is meant by the electrical activity of the heart, how would you describe it?
- How is heart rate regulated? Control of Cardiac Output
- What are the factors important to regulating Cardiac Output?
- What is a vascular function curve (model)?
- What is a cardiac function curve (model)?

Microcirculation

- What is the microcirculation?
- Broadly, what kinds of capillaries are there?
- What is the Law of Laplace?
- How does flow occur down the capillary?
- How does flow occur across the capillary wall?

Blood Pressure Regulation

- What blood pressure is regulated?
- What are the major components of blood pressure regulation?
- How do they work together?

• Module 5 Respiration and Gas Exchange Structure and Function of the Respiratory System

- How are the structure and function of the lung related?
- What is a gas exchange unit?
- How does the respiratory control system work in general? Lung Mechanics
- What are the major parts of the lung and chest wall?
- What causes gas to flow into, within and out of this system?
- How are the pressures in different part of the system related?
- How does resistance/conductance influence the flow of gas?
- What is Poiseuille's Law (model)? Ventilation and Perfusion
- What are the components of alveolar ventilation?
- What is the relationship between alveolar ventilation and deadspace ventilation?
- How are CO₂ and O₂ related to each other in the lung?
- What is lung perfusion?
- What does the VAQ ratio represent?

Gas Transport

- How is O₂ transported by blood?
- How is CO₂ transported by blood?

Regulation of Ventilation

- What blood variables are regulated?
- Where are the sensor?
- Where is the controller located?
- What are the effectors and how do they operate?

• Module 6 Renal

- How are the structure and function of the kidney interrelated?
- Describe how the model for GFR works.
- How is GFR regulated?
 - What is clearance?
 - How does kidney filtration operate? Tubular Transport
- How does tubular transport operate?
- How might you construct a mass balance model on the kidney?
 - What is the difference between reabsorption and secretion?

Fluid Balance

- What is countercurrent exchange?
- – What is countercurrent multiplication?
- Where in the kidney do you find variable water permeability of membranes?
 - – To what extent can human kidneys concentrate urine and how is it done?
 - – What happens when the kidney is excreting excess water?

• Module 7 Endocrinology

Principles

- What the general mechanisms of action?
- What types of feedback control are there?
- How would you classify the major types of interaction?
- How do control circuits describe endocrine (in the large sense) interactions?
- What is the afferent limb?
- What is the efferent limb?
- What is the regulated variable?
- What is a Physiological Response as compared to an Endocrine Axis Response?
- What are the major types of signalling molecules?
- Where are cellular receptors located?
- How is receptor location related to types of signalling molecule?
- What happens after the signalling molecule is recognized by the receptor?

Hypothalamus and Pituitary

- What does the term Hypothalamic-Pituitary Axis mean?
- What is the Pituitary and where is it located?
- Describe the Hypothalamic-Pituitary axis with a system diagram.
- What are releasing, inhibiting and trophic hormones (signalling molecules)?

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Class Schedule

Lecture	Topic	Date	Reading
	Introduction and Transport: Module 1		
1	Introduction, Modeling, Transport	Aug 25	Chap 1
2	Transport	Aug 27	Chap 1
3	Transport	Aug 29	Chap 1
	Labor Day No Lecture	Sept 1	
4	Water Transport	Sept 3	Chap 1
5	Signal Transduction, an Introduction	Sept 5	Chap 3
	Neurophysiology: Module 2		
6	Membrane Resting Potential	Sept 8	Chap 1,2
7	Membrane Resting Potential	Sept 10	Chap 1,2
8	Action Potential	Sept 12	Chap 5
9	Action Potential and Conduction	Sept 15	Chap 5
10	Synaptic Transmission	Sept 17	Chap 6
	Skeletal and Smooth Muscle: Module 3		
11	Skeletal Muscle- Structure and Function	Sept 19	Chap 12
12	Skeletal Muscle- Sliding Filaments	Sept 22	Chap 12
13	Skeletal Muscle- Sliding Filament	Sept 24	Chap 12
14	Skeletal Muscle- EC Coupling	Sept 26	Chap 13
15	Skeletal Muscle- EC Coupling	Sept 29	Chap 14
16	Smooth Muscle	Oct 1	Chap 14
	Cardiovascular Physiology: Module 4		
17	Cardiovascular System- Structure and Function	Oct 3	Chap 15
18	Cardiovascular System- the Heart	Oct 6	Chap 13
19	Cardiovascular System- the Heart	Oct 8	Chap 15
20	Cardiovascular System- the Heart	Oct 10	Chap 17
21	Cardiovascular System- Heart Vasculature Coupling	Oct 13	Chap 17
22	Cardiovascular System- Heart Vasculature Coupling	Oct 15	Chap 21
23	Cardiovascular System- Microcirculation	Oct 17	Chap 17
24	Cardiovascular System- Microcirculation	Oct 20	Chap 20
	Respiratory Physiology: Module 5		
25	Respiration- Lung Structure and Function	Oct 22	Chap 25
26	Respiration- Gas Exchange	Oct 24	Chap 24
27	Respiration- Lung Mechanisms	Oct 27	Chap 27
28	Respiration- Lung Mechanisms	Oct 29	Chap 29
29	Respiration- Ventilation and Perfusion	Oct 31	Chap 28
30	Respiration- Ventilation and Perfusion	Nov 3	Chap 28
31	Respiration- Blood Gas Transport	Nov 5	Chap 29
32	Respiration- Blood Gas Transport	Nov 7	Chap 29
	Renal Physiology: Module 6		
33	Renal Physiology- Renal Structure and Function	Nov 10	Chap 34
34	Renal Physiology- GFR and Clearance	Nov 12	Chap 34
35	Renal Physiology- GFR and Clearance	Nov 14	Chap 35
36	Renal Physiology- Tubular Transport	Nov 17	Chap 35
37	Renal Physiology- Tubular Transport	Nov 19	Chap 35
38	Renal Physiology- Tubular Transport	Nov 21	Chap 36
	Final Exam	May 5-9	
39	Renal Physiology- Fluid Volume Regulation	Dec 1	Chap 36
	Endocrine Physiology: Module 7		

40	Endocrinology- General Principles	Dec 3	Chap 36
41	Endocrinology- Regulation of Secretion	Dec 5	Chap 38
42	Endocrinology- Hypothalamus and Pituitary	Dec 8	Chap 39
43	Endocrinology- Hypothalamus and Pituitary	Dec 10	Chap 39
44	Endocrinology- Hypothalamus and Pituitary	Dec 12	Chap 43
	Final Exam Week	Dec 15-20	