ENDOCRINOLOGY

(BIO 448, Fall 2017, Course ID#19035)

Dr. Christopher A. Loretz
Office: 647 Hochstetter Hall
Office Phone: 645-4985
e-mail: loretz@buffalo.edu

Office Hours: Tu & Th 8:30-9:15 a.m.,
M, W & F 08:00-08:45 a.m.,
and by appointment

Time/Place: Tu & Th 9:30-10:50 a.m.
215 Natural Sciences Complex, North Campus

Course Aim: BIO 448 is an introduction to the biology of chemical mediation at the organismal, cellular and molecular levels. Whereas emphasis will be on the regulation of physiological and other processes in vertebrates (especially mammals), lectures and readings are designed to present principles and concepts that are applicable to other taxonomic groups as well.

Learning Objectives: Students successfully completing this course will:

- [1]understand basic principles of homeostatic regulation of biological systems;
- [2]be familiar with the tools and techniques used in the study of hormones and chemical messengers;
- [3]know the structures and biosynthetic pathways of major families of chemical messengers;
- [4]recognize the diversity of hormone receptor systems and transduction pathways;
- [5]acquire a systems-based working knowledge of important hormonally-regulated physiological processes;
- [6]master basic quantitative skills important for analyzing, understanding and presenting endocrinological data;
- [7]appreciate current scholarly and popular issues in endocrinology; and
- [8]be able to find and access primary literature resources, and to synthesize current knowledge in reporting on a topic of endocrinological interest.

Assessment: Student achievement of learning objectives will be assessed by:

- two hourly exams and a comprehensive final exam of combined multiple-choice and free-response questions, for testing knowledge acquisition (learning objectives 1-5, and 7) and quantitative skills development (learning objective 6);
- occasional worksheets and homework sets, for developing and testing quantitative skills mastery (learning objective 6); and
- a written term project, for measuring library and scientific reporting skills development (learning objectives 6-8).

Texts: ***[Required]*** Kovacs & Ojeda (eds.), *Textbook of Endocrine Physiology*, 6th edition, Oxford University Press, 2012; ISBN-10: 0199744122; ISBN-13: 978-0199744121; available at the campus bookstore, or from on-line booksellers.

[Recommended; do not purchase this, but do use whatever you already own] Sadava *et al*., *LIFE: The Science of Biology*; *or* an equivalent, current, comprehensive biology or physiology text that you already own.

[Optional; do not purchase] Resource books available to you in the library:
Norris, *Vertebrate Endocrinology*, 4th edition, 2007
Hadley & Levine, *Endocrinology*, 6th edition, 2007
Norman & Litwack, *Hormones*, 2nd edition, 1997

Attendance: Perfect lecture attendance by each registered student is expected. This expectation of regular attendance is intended to promote student and overall class learning. Documented medical and other legitimate, urgent absences from exams will be excused. For expected and/or planned absences during an exam (academic program interviews, scheduled medical procedures, *etc*.), please notify the course instructor (Dr. Loretz) in advance. Any student absent without notice from an exam and without a physician's written note of excuse or other documentation of urgency will receive a zero for the exam.

Participation: Class participation is encouraged throughout the semester and, especially, during presentations of methodologies and techniques involving mathematical analyses, interpretation of experimental data, and subjects not covered in the primary text readings. Active student engagement in discussion and in question-and-answer periods will promote comprehension and learning.

Grading: Grades will be calculated and determined according to the following scheme:

First Exam	100 points
Second Exam	100 points
Final Exam	125 points
Term Project	50 points
Worksheets/Homework	25 points
Total	400 points

The first and second exams will focus on course material from defined blocks of lectures (please refer to the course schedule included in this document). The final exam will emphasize material from the final block of lectures and will additionally include questions that are comprehensive, integrative or cumulative, or simply review in nature. Each student will be graded carefully and fairly. All exams (first, second, and final) and the term project must be completed in order to pass this course. For point credit, in-class worksheets must be completed and submitted on the day of the activity, and homework assignments must be submitted on the due date. Late submissions and make-up work will not be accepted. Since it is not unexpected that the typical student might miss one activity due to unforeseen circumstances, the score for one in-class worksheet or homework activity will be dropped in the final calculation. Based on the anticipated 12 worksheet and homework assignments during the semester, each item carries a value of about 2 points. Missing one, or even two, assignments will, for the typical student have negligible effect on total point accumulation and final grade. For students who regularly miss class, point loss will be greater. Students missing class because of an extended illness should, of course, contact the instructor with medical documentation for worksheet and homework point compensation requests.

Final course grades will be based on total point accumulation by each student, according to the following scheme:

355-400 points = A-/A
320-354 points = B-/B/B+
270-319 points = C-/C/C+
230-269 points = D/D+

Each student's accomplishment, both overall and on the several contributors to total point score, will be evaluated during final course grade assignment.

Incomplete "I" grades will be assigned only in accordance with University policy. The University has a specific and well-defined policy regarding the Incomplete "I" grade. The I grade is not intended for cases of non-attendance or unexcused absences from class exams or other activities. The complete University policy for the Incomplete "I" grade is available on-line at:

http://undergrad-catalog.buffalo.edu/policies/grading/explanation.shtml#incomplete

Academic honesty is important, and each student is expected to do and to submit her/his own work according to instructions. Some in-class activities and out-of-class homework assignments may include

allowances for among-student consultation or collaboration, but, in the end, each student should nevertheless submit her/his own paper. The University has an academic integrity policy that applies to this course. The policy is published in the Undergraduate Catalog and elsewhere, and students are asked to review this policy if they are not already familiar with it. The URL for the official University policy is:

http://undergrad-catalog.buffalo.edu/policies/course/integrity.shtml

Academic Policies and Procedures: The on-line version of the Undergraduate Catalog contains a full, detailed presentation of University policies relating to academic policies and procedures. All students should be familiar generally with the University's policies relating to course expectations and to grading, and to other matters. These are available at:

http://undergrad-catalog.buffalo.edu/policies/

Attendance: Perfect lecture attendance by each registered student is expected. This expectation of regular attendance is intended to promote student and overall class learning. Documented medical and other legitimate, urgent absences from exams will be excused with proration of the exam score. For expected and/or planned absences during an exam (academic program interviews, scheduled medical procedures, *etc*.), please notify the course instructor (Dr. Loretz) in advance for excusal with proration of the exam score. Any student absent without notice from an exam and without a physician's written note of excuse or other documentation of urgency will receive a zero for the exam.

Participation: Class participation is encouraged throughout the semester and, especially, during presentations of methodologies and techniques involving mathematical analyses, interpretation of experimental data, and subjects not covered in the primary text readings. Active student engagement in discussion and in question-and-answer periods will promote comprehension and learning.

Accessibility Resources: If you have a disability and require some type of instructional and/or examination accommodation, please inform the instructor early in the semester so that accommodations can be arranged. If you have not already done so, please contact the university's Office of Accessibility Resources. The office is located at 25 Capen Hall and the telephone number is 645-2608. Classroom instructional and exam accommodations will be made for students individually on the advice and guidance of the Office of Accessibility Resources. The Office of Accessibility Resources will host proctored exams for students with accommodations. It is the responsibility of the student to make the appropriate reservations in that case. For a full description of available services, refer to the Office of Accessibility Resources Web site at:

http://www.student-affairs.buffalo.edu/ods/

Religious Accommodation: Any student desiring a reasonable religious accommodation should make the request directly to the course instructor. It is expected that the student will provide sufficient notice of the need for an accommodation to the course instructor in order for the accommodation to be implemented. In the event that a student's request for religious accommodation involves an exam, the student will be excused from the exam (with proration of a score) in order to meet her/his religious needs. If there are concerns about the requested accommodation, the instructor should consult his/her department chair, dean's office and/or the university's Office of Equity, Diversity and Inclusion (EDI). The instructor will not unilaterally deny a request for a reasonable religious accommodation without first consulting EDI. The EDI Web site is:

http://equity.buffalo.edu/

Course Management System: All registered students have access via UBlearns (http://ublearns.buffalo.edu) to the BIO 448 Endocrinology course content area. Please monitor regularly for posted announcements and class assignments from the instructor, and for other useful course documents and links.

Annotated Bibliography Term Project

The term project provides each student independently the opportunity to explore and to report on an endocrine topic of personal interest. The selection of topic is up to each student, with the approval of the course instructor. Students may select any topic appropriate to the field of endocrinology or chemical communication broadly. At the first exam, as one of the exam questions, students will be asked to identify their individually-selected topic for approval by the instructor.

An annotated bibliography is a collection of citations to primary research papers and/or review articles from refereed scientific journals. Each of the articles selected for inclusion on the bibliographic list should have informative value to a scientific reader seeking to know something about a topic. The target reading audience is a trained life scientist, but not a specialist in endocrinology. Value to the reader may come in the form of historical perspective to the topic, description of a new or interesting experimental technique applied to the topic, a recent finding that challenges current thinking on the topic, etc. There are two components to each entry in the bibliography: (1) a complete citation to the paper in a standard journal format (neither URLs nor DOIs are required); and (2) a brief, 2-4 sentence summary of the major points or findings from the work, or of the significance of the work. The brief summary is not a re-statement or abridgement of the abstract. Instead, it is the bibliography writer's succinct statement of the key findings in the published report, or of the significance to the field of the referenced work. An example bibliography is provided below.

The final submitted project should begin with a title for the bibliography writer's selected topic, and a one-paragraph introduction that prepares the reader for the bibliographic listings. Include at least 5 references, but not more than 7 references. Projects should be submitted in printed form, and should not exceed 2 pages in length. A sample format is provided on the next page. Formatting of the bibliographic entries can follow any of the widely used standards, as long as the citation includes the essential information of author name(s), article title, journal name, volume number and pages, and publication date.

Most scientific journals have on-line access to their articles. Students have free access to the many articles in those journals for which the university's library holds subscriptions. Access these journals through the University Libraries web portal at http://library.buffalo.edu. The University Libraries web site also provides on-line access to searchable bibliographic databases such as *Web of Science* and *MEDLINE*. Be aware that on-line newspaper and popular magazine articles, and information posted to wikis and other internet sites are not peer-reviewed or refereed in the widely-accepted scientific sense. Although these resources may be useful in helping to explore topics, please do not include these postings, articles, and web sites in the annotated bibliography—***use only primary literature reports and reviews from reputable, established journals***. If in doubt when selecting your bibliography citations, ask the instructor.

The project is due on the last day of class (Thursday, 12/07/2017).

[*EXAMPLE FORMAT—DO NOT INCLUDE BRACKETED TEXT IN YOUR SUBMISSION*]

[*STUDENT BIBLIOGRAPHER'S NAME AT TOP OF FIRST PAGE*]
Jane/John Student
BIO 448 Endocrinology, Spring 2017

[*TOPIC TITLE*]

Extracellular Calcium Sensing in Fishes

[*INTRODUCTION*]

Sensing of ionic calcium in the extracellular body fluids (in the blood, specifically) of vertebrates is important because of the critical involvement of calcium in physiological processes. Examples of such processes include synaptic neurotransmitter release, excitation-contraction coupling in muscle, and stimulus-secretion coupling in endocrine cells. Homeostatic control systems must be able to sense the calcium ion concentration, and to respond in appropriate fashion to maintain steady state. Homeostatic balance in fishes is challenged by changes in the external calcium concentration. For example, a salmon migrating from a freshwater stream to the ocean leaves an environment where the external concentration of calcium is lower than that of the blood plasma and extracellular fluids (typically in the range of 2-3 mmole·L^{-1}) and enters one where the concentration is higher. The membrane-bound extracellular calcium-sensing receptor may be the physiological sensor in the homeostatic feedback regulatory system.

[*ANNOTATED BIBLIOGRAPHY ENTRIES; three examples of the 5-7 that are required*]

Brown EM., *et al*. Cloning and characterization of an extracellular Ca^{2+}-sensing receptor from bovine parathyroid. *Nature* **366**: 575-580, 1993.
[DOI: 10.1038/366575a0]

This is the first published report of the vertebrate calcium-sensing receptor, isolated from the parathyroid gland of cows. The membrane-bound, cell surface receptor is a member of the G-protein coupled receptor (GPCR) family of proteins. Expression of the receptor in Xenopus oocytes revealed that the receptor is promiscuous, recognizing and binding not only calcium ions, but also other multivalent cations and substances such as the antibiotic neomycin.

Loretz CA, Pollina C, Hyodo S, Takei Y, Chang W, and Shoback D. cDNA cloning and functional expression of a Ca^{2+}-sensing receptor with truncated carboxyterminal tail from the Mozambique tilapia (*Oreochromis mossambicus*). *J. Biol. Chem.* **279**: 53288-53297, 2004.
[http://www.jbc.org/cgi/reprint/279/51/53288]

This paper reports on the molecular cloning and sequencing of a teleost fish extracellular calcium-sensing receptor (CaSR). The cloned tilapia CaSR cDNA was expressed in a cultured cell line to confirm the functional properties of the receptor. Although the teleost CaSR has a shorter C-terminal intracellular tail than tetrapod CaSRs, it is nevertheless capable of signal transduction in response to stimulation of calcium. By RT-PCR analysis, the receptor is expressed in both ion-transporting osmoregulatory and hormone-secreting endocrine tissues.

Loretz CA, Pollina C, Herberger AL, Hyodo S, and Takei Y. Skeletal tissues in Mozambique tilapia (*Oreochromis mossambicus*) express the extracellular calcium-sensing receptor. *Comp. Biochem. Physiol. A: Molec. Integr. Physiol.* **163**: 311-318, 2012. [http://dx.doi.org/10.1016/j.cbpa.2012.07.015]

Using reverse transcription-polymerase chain reaction (RT-PCR) and immunohistochemical staining, calcium-sensing receptor expression was demonstrated in various skeletal tissues, including both bone and cartilage, of the bony fish tilapia. These observations support the findings of studies on mammals that CaSR is expressed in skeletal tissues, and the suggestion that CaSR, in addition to its role in the endocrine regulation of circulating calcium concentrations, it is an important controller of normal bone growth and development and function.

Herberger AL, and Loretz CA. Morpholino oligonucleotide knockdown of the extracellular calcium-sensing receptor impairs early skeletal development in zebrafish. *Comp. Biochem. Physiol. A* **166**: 470-481, 2013.
[http://dx.doi.org/10.1016/j.cbpa.2013.07.027]

Using a morpholino oligonucleotide knockdown technique to block proper mRNA splicing, the involvement of calcium-sensing receptor in normal skeletal development was demonstrated in zebrafish. Receptor knockdown caused developmental deformities in the axial skeleton. Based on similar dependence in mice, calcium-sensing receptor may play an essential role in skeletal development in all vertebrates.

Daily Class Schedule

Week	Date	Lecture	Topic	Reading (Kovacs & Ojeda, 6/e)
Week 1	08/29 (T) 08/31 (R)	1 2	Nature of Chemical Mediation & Endocrine Systems Tools & Techniques I	Ch. 1 (pp. 3-20) Ch. 2 (pp. 21-57) Ch. 4 (pp. 99-115)
Week 2	09/05 (T) 09/07 (R)	3 4	Tools & Techniques II Mechanisms of Hormone Action	" Ch. 3 (pp. 58-98)
Week 3	09/12 (T) 09/14 (R)	5 6	Neuroendocrinology/Neurosecretion Hypothalamo-Hypophysial Axis	Ch. 5 (pp. 116-125, 132-137) Ch. 6 (pp. 120-125, 148-150)
Week 4	09/19 (T) 09/21 (R)	7 8	Posterior Pituitary Gland Anterior Pituitary Gland I	Ch. 6 (pp. 149-171) Ch. 5 (pp. 116-147)
Week 5	09/26 (T) 09/28 (R)	9 10	Anterior Pituitary Gland II Catch-up, Special Topic and/or Pre-Exam Round-Up	Ch. 11 (pp. 292-310) *(no reading assignment)*
Week 6	10/03 (T) 10/05 (R)	 11	***EXAM 1 (covers lectures of 8/29-09/28, 10 lectures)*** Steroid Chemistry and Metabolism I	 Ch. 13 (pp. 346-373, 378-380)
Week 7	10/10 (T) 10/12 (R)	12 13	Steroid Chemistry & Metabolism II Sexual Differentiation and Sexual Reproduction	" Ch. 7 (pp. 172-193)
Week 8	10/17 (T) 10/19 (R)	14 15	Testis and Male Endocrine Physiology Ovary and Female Endocrine Physiology	Ch. 9 (pp. 239-263) Ch. 8 (pp. 194-238)
Week 9	10/24 (T) 10/26 (R)	16 17	Pregnancy & Lactation Thyroid Gland	Ch. 10 (pp. 264-291) Ch. 12 (pp. 311-345)
Week 10	10/31 (T) 11/02 (R)	18 19	Parathyroid Gland & Ultimobranchial Bodies Catch-up, Special Topic and/or Pre-Exam Round-Up	Ch. 14 (pp. 381-410) *(no reading assignment)*
Week 11	11/07 (T) 11/09 (R)	 18	***EXAM 2 (covers lectures of 10/5-11/02, 9 lectures)*** Gastrointestinal Physiology I	 *(no reading assignment)*
Week 12	11/14 (T) 11/16 (R)	19 20	Gastrointestinal Physiology II Metabolic Endocrinology I	" Ch. 13 (pp. 373-378)
Week 13	11/21 (T) 11/23 (R)	21	Metabolic Endocrinology II ***Fall Recess—No Class***	Ch. 15 (pp. 411-440)
Week 14	11/28 (T) 11/30 (R)	22 23	Invertebrate Endocrinology I Invertebrate Endocrinology II	*(no reading assignment)* "
Week 15	12/05 (T) 12/07 (R)	24 25	Origins of the Endocrine System Environmental Endocrinology & Pre-Exam Round-Up ***ANNOTATED BIBLIOGRAPHY PROJECT DUE***	" "
Final Exam Week	12/14 (R) 8:00-11:00 am 216 NSC		***FINAL EXAM (covers lectures of 11/09-12/7, 8 lectures; plus comprehensive/integrative/cumulative component covering entire course)***	

Special Note: The assigned readings sometimes cover topics in a level of detail that, because of the very fine focus on specific clinical conditions or quantitative values, extends well beyond the scope of this class. Do not panic. With initial guidance, you will quickly learn to identify such chapter segments. You may safely skim these passages and pages without hazard. When in doubt, do not hesitate to ask.

Relationship of BIO 448 Course Objectives and Assessment to BIO Program Objectives

BIO Program Objective	Depth*	Specific Outcome Objectives for BIO 448	Assessment Instrument(s)
1. Provide breadth of knowledge of basic principles and concepts	1	Understand basic universal principles of chemical signaling, and the nature of hormonal communication in simple and complex organisms	Exam 1, and final exam
		Comprehend homeostasis, and positive and negative feedback control	Exam 1, and final exam; and worksheets
		Understand importance of functional integration among cells, tissues and organs for survival of the organism	Exams 1 and 2, and final exam; and worksheets
2. Provide depth within specialized areas	2	Describe interaction of biological signaling molecules with their receptors in quantitative fashion	Exams 1 and 2, and final exam; and worksheets
		Understand the chemical and physical properties of biological signaling molecules	Exam 1, and final exam; and worksheets
		Understand hierarchical control (endocrine axes) of physiological systems	Exams 1 and 2, and final exam; and worksheet
		Apply endocrinological principles to understanding regulation of physiological and developmental systems across the animal kingdom	Exam 2, and final exam; and worksheets
3. Provide an understanding of experimental design and methodology	0	N/A	N/A
4. Develop approaches for integration of information	2	Relate application of analytical techniques for assessing endocrine status to extraction and interpretation of useful biological information	Exams 1 and 2, and final exam; and worksheets
		Integrate endocrinological knowledge across scales of size (subcellular/cellular/tissue/organ/organism) to explain adaptive responses of organisms to challenge	Exam 2, and final exam; and worksheets
5. Encourage critical thinking and hypothesis building	1	Analyze and interpret real and simulated data from endocrinological observations and experiments	Exams 1 and 2, and final exam; and worksheets
		Describe current status of an endocrine topic or question, supported by primary literature references and synopsis of impact and relevance to the field	Term project
6. Provide skills in scientific communication	1	Express topic understanding in clear prose	Freeform response questions of Exams 1 and 2, and final exam; and term project
		Relate methods, processes and conclusions of data analysis and interpretation in clear narrative and in technically-correct quantitative graphical/diagrammatic form	Freeform quantitative response questions of exams 1 and 2, and final exam; and worksheets
7. Provide contemporary information	2	Understand contemporary endocrine issues relating to physiological acclimation and adaptation, and survival of organisms	Final exam; and term project
		Appreciate the complex endocrine interplay among organisms and the environment	Exam 1, and final exam; and term project
8. Encourage appreciation of scientific values	1	Recognize proper and correct interpretation of endocrinological data collected from the field and from the laboratory	Exams 1 and 2, and final exam; and worksheets
		Identify the importance of endocrinological knowledge to understanding biosystems generally, and the implications of that knowledge in informing scientific and public policy	Exams 1 and 2, and final exam

*Depth: 0 = not covered; 1 = moderately covered; 2 = extensively