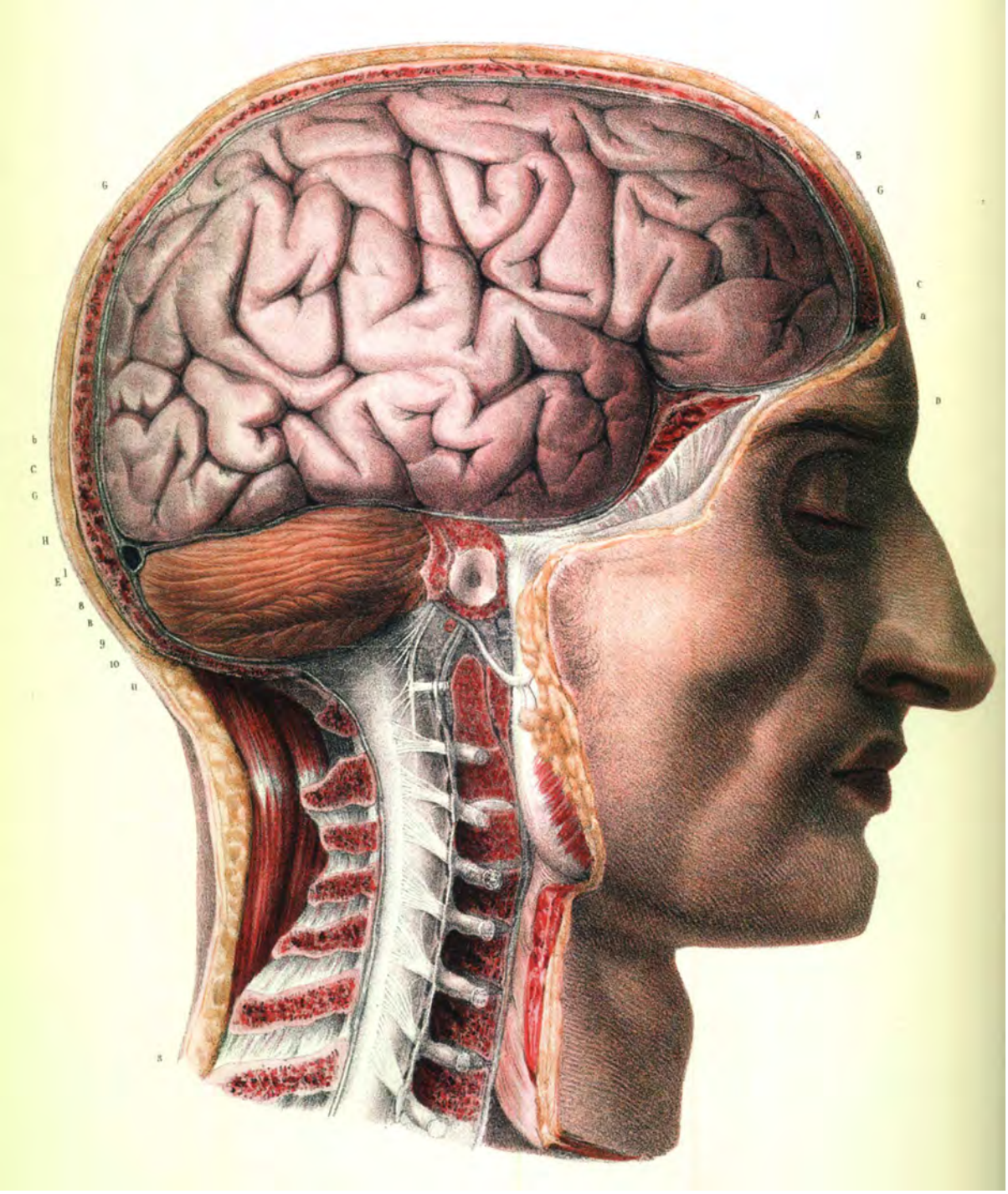
MAMMALIAN NEUROANATOMY



David Larue and Henk Roelink
Fall, 2015

University of California at Berkeley
Molecular and Cell Biology 163

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Preface

This course provides you with a basic understanding of the principles of brain structures and function. These concepts will be useful in graduate or medical studies, and they can refine your ideas about biological complexity and order. The course is designed to prepare you for the advanced neuroscience courses that are an essential part of the postgraduate curriculum. Our emphasis is therefore more integrative and broadly-based than in most neuroanatomy courses. In addition to the fundamental structural biology of the central and autonomic nervous systems we will study developmental neurobiology, the sensory, motor and limbic systems, as well as aspects of neurochemistry, neuropathology, and language. These are essential ingredients of a global perspective on modern neuroscience.

Cover

Jean-Baptiste Marc Bourgery [1797–1849] was a French physician and anatomist who was a native of Orléans. He wrote and illustrated several textbooks of surgical anatomy. He began his studies in 1815 under naturalist Jean Baptiste Lamarck (of *giraffe neck stretching theory of trait emergence in phylogeny* - infamy). He worked as a technician in several Paris hospitals before finally completing his medical degree in 1827.

Acknowledgments

Dedication: To the late Professor Jeffery Winer, who conceived and designed this course and taught it for almost two decades.

Acknowledgments: We want to thank Fei Lin and Mark Henteleff of Instructional Support for their continuing assistance with the facility and supplies used in the laboratory. Likewise, we thank Stephanie Lim of the Academic Services unit for her unflagging assistance with administrative solutions and resources. Human brain specimens for dissection and study were obtained from the Dept of Integrative Biology and facilitated by Ms. Jill Marchant. We also want to thank Katie Dorsch Smith of the Feldman lab for help preparing rat brain specimens for the histology unit. Finally, we want to acknowledge the great work of Amit Sarna and his associates at Replica Copy for the terrific job they do printing this lab manual.

David Larue and Henk Roelink

MCB 163 Mammalian Neuroanatomy
4 units

Lecture:	Tuesday and Thursday, 12:30-2:00 p.m.
Location:	Room 101 Barker
Laboratory:	Tuesday, 9:00-11:00 p.m. (section 103)
	Tuesday, 3:00-5:00 p.m. (section 101)
	Thursday, 9:00-11:00 a.m. (section 104)
	Thursday, 3:00-5:00 p.m. (section 102)
Location:	Room 4048 Valley Life Sciences Building

Instructor:	David Larue <dtlarue@berkeley.edu>
Office:	134 Life Sciences Addition
Office Hours:	Friday 2:00 p.m. - 4:00 p.m.
Instructor:	Henk Roelink <roelink@berkeley.edu>
Office:	171 Koshland
Office Hours:	Friday 1:00 p.m. to 3:00 pm
GSIs	Jocelyn Breton <jbreton@berkeley.edu>
	Franklin Caval-Holme
	<franklin.caval-holme@berkeley.edu>
Office Hours:	Tuesday and Thursday, 5:00-6:00 p.m.; 4048 VLSB

Textbooks

1. Kandel, E.R., Schwartz, J.H., Jessell, T.M., Siegelbaum, S.A., Hudspeth, A.J. Principles of Neural Science. Fifth edition, McGraw-Hill, 2013.
2. Martin, J.H. Neuroanatomy. Text and Atlas. Fourth edition. McGraw-Hill, 2012.
3. Larue, D.T. and Roelink, H. Laboratory Manual for MCB 163. The printed lab manual/syllabus contains the organizational pages, the lab guides and a rat brain atlas. Other resources, (lecture pdf files, a glossary, sample exam questions and study guides) will be posted on the bCourses site. It will be available at Replica Copy on Oxford St. (across from campus) the week before labs begin.

Course policies

1. The lectures presume that you have done the assigned reading.

2. Examinations
   A. No makeups* – We do not offer makeup exams if either a classroom or laboratory exam is missed because of an unexused absence. A 5-page research paper will substitute for the missing score. *The best score possible will be the mean obtained by the class on the missed exam.*
   B. If you have official school travel that conflicts with an exam, we can let you take the exam early to accommodate.
   C. Adjustments on test scores must be negotiated with your GSIs – with input from the instructors if necessary
   D. First two laboratory exams are timed, powerpoint format - 3rd lab exam is written question format (included in final).
   E. Lecture exam format consists of short essays, matching, true/false and multiple choice.
   F. Review sessions can be arranged with your GSIs
   G. Course is graded on a percentage scale - not a fixed curve The weighting of the examinations is:

Classroom exams (4 @ 12.5% each of final grade)	: 50%
Classroom final (1 @ 20% of final grade) cumulative but but stresses large concepts	: 20%
Laboratory examinations (3 @ 10% each of the final grade, exam 3 is given with the final)	: 30%
Total	:100%

3. Attendance in laboratory sessions is **required** A laboratory missed for a medical reason (illness, etc.) can be made up through arrangement with your GSI. More than one missed lab requires a written excuse from a relevant health professional on their letterhead within one week. Labs missed for other than medical or official school function reasons are considered unexcused and cannot be made up. It is not fair to the GSI's to have to arrange make-up labs for students who miss a lab for elective reasons. Official school-related excused absences include trips for music or sports activities or travel for scientific meetings, med. school/grad school interviews, etc. Only one unexcused absence from a lab is permitted. A subsequent unexcused laboratory absence will decrease your score on the next lab exam by 10%.

4. Lecture slides will be posted on bCourses before class.

5. Teaching Evaluations are now done online: Please bring to class any mobile device on Dec. 1. We will set aside 10 minutes to complete faculty evaluations.

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Teaching staff

1. **Henk Roelink**, Associate Professor of Genetics, Genomics and Development

• Scholarly interests and background:

Henk Roelink has a long-standing interest in the development of the central nervous system. His studies have focused on the molecular nature and mechanism of action of signaling molecules involved in the induction of distinct neurons in the developing CNS. He has a PhD from the University of Amsterdam based on research performed at the Netherlands Cancer Institute and Stanford University. He was a post-doc in the lab of Thomas Jessell (the co-author of the Principles of Neural Science textbook) at Columbia University in New York, and has worked at the University of Washington School of Medicine in Seattle before moving to UC Berkeley.

• Teaching experience:

Henk Roelink has taught both gross- and neuroanatomy to medical students during his tenure at the University of Washington School of Medicine and has taught MCB 163 since 2012. He also teaches genetics and animal development to graduate and undergraduate students. He likes to teach anatomy from a developmental perspective.

2. **David Larue**, Lecturer in Neurobiology

• Scholarly interests and background:

David Larue received his undergraduate education in Biology and Psychology at the UC, Santa Cruz and did his graduate studies in Anatomy at UC, San Francisco. He is accomplished in small animal neurosurgery, neurohistology, immunohistochemistry and light and electron microscopy/photomicroscopy.

• Scholarly interests and background:

Starting here in 1981, in the Dept of Physiology and Anatomy (pre-MCB), he spent most of his career running the laboratory of the late Professor Jeffery Winer, investigating the anatomy and neurochemistry of the central auditory pathways in mammals.

• Teaching experience:

He has taught medical gross anatomy at UCSF and at UC Berkeley Extension; Neuroscience at UC Berkeley Extension and here at Berkeley, he has taught this course (MCB163) since 2010 as well as MCB 160L since 2009. Starting summer of 2015, he taught MCB 63, a lower division introduction to neuroanatomy.

3. **Jocelyn Breton**, graduate student, currently Dr. Howard Field's laboratory at UCSF. She did her undergraduate work at Middlebury College. She is interested in the neurobiological substrates of mental disorders like anxiety and schizophrenia and how stress influences their incidence and severity.

4. **Franklin Caval-Holm,** graduate student in the Feller Lab. Franklin did his undergraduate work at Stanford University. He is interested in how light modulates spontaneous activity and synaptic refinement in the retina during development.

Disabled students program (DSP)

• Please contact the instructors if you are taking this course needing accommodations under the DSP so we can plan accordingly. All efforts will be made to furnish you with needed accommodations for exams.

How to use this book

1. The syllabus/lab manual is spiral bound and protected with plastic covers. It is meant to be used in the lab sessions and is built to take some punishment. Figures are frequently repeated to avoid having to flip back and forth. The lists of terms in many of the laboratory exercises is a useful tool to assist you in mastering the language of neuroanatomy. Filling in the definitions each week before the laboratory is the best way to become fluent in this new vocabulary. Think of it as a weekly test that you can self-administer. A useful approach is to take every new term you encounter and begin to construct your own glossary. The more familiar you are with the nomenclature, the better equipped you are to answer the questions posed in exams and more importantly, communicate efficiently about this complex topic as you further your education, training and career.

2. A comprehensive glossary will be posted on bCourses in a printable format, if you desire a hard copy.

MCB 163 ~ LECTURE/EXAM SCHEDULE

August 27	Roelink	(1) Org of the brain/Web Resources I	M 3-26 57-82; K 5-18, 337-354
September 1	Roelink	(2) Org of the brain/Web Resources II	URLs in the presentation
September 3	Larue	(3) Neurocytology	K 21-38, 72-97
September 8	Roelink	(4) Developmental neuroanatomy	K 1165-1230
September 10	Larue	(5) Cranial nerves I - overview	M 127-151, 255-273
September 15	Roelink	(6) Spinal cord	M 227-251; K 790-810
September 17	Roelink	(7) Dorsal column system (touch)	M 85-103; K 498-527
September 22	Roelink	(8) Spinothalamic system (pain)	M 107-123; K 530-553
September 22		**Lecture Exam #1 2050 VLSB 7pm**	
September 24	Roelink	(9) Cranial nerves II: Trigeminal complex	M 127-151; K 1019-1036
September 29	Larue	(10) Thalamus	M 45-48; K 360-368
September 30		**Lab exam #1 145 Dwinelle 7pm**	
October 1	Larue	(11) Cerebral cortex and corticofugal pathways	M 29-54; K 337-354, 392-4
October 6	Larue	(12) Cerebellum	M 299-324; K 960-97
October 8	Larue	(13) Basal Ganglia	M 325-348; K 982-998
October 13	Larue	(14) Control of muscle and movement	M 127-148; K 835-892
October 15	Larue	(15) Vestibular system	M 277-295; K 917-9
October 15		**Lecture Exam #2 145 Dwinelle 7pm**	
October 20	Larue	(16) Auditory system I: periphery, receptors/transduction	K 654-680
October 22	Larue	(17) Auditory system II: central pathways	M 181-196; K 682-710
October 27	Roelink	(18) Visual system I: periphery, the eye/retina	K 577-600
October 28		**Lab exam #2 145 Dwinelle 6pm***	
October 29	Larue	(19) Visual system II: central pathways	K 602-619
November 3	Roelink	(20) Gustation/olfaction	M 201-220; M 712-134
November 5	Roelink	(21) Neural basis for speech and language	K 1353-13710
November 5		**Lecture Exam #3 100 GPB 7pm**	
November 10	Larue	(22) Neuropathology	K 307-329, 999-1012, 1425-1439
November 12	Roelink	(23) Hippocampus, the ancient cortex	M 217, 385-394; K 1487-1518
November 17	Roelink	(24) Hypothalamus: autonomic nervous system	M 355-383; K 961-981
November 19	Roelink	(25) Limbic system	M 385-411; K 1487-1518
November 24, 26		No lecture or lab this week - Happy thanksgiving!	
December 1	Larue	(26) Chemical neuroanatomy	K 1038-1054
December 3		**Lecture Exam #4 (in class)**	
December 18		**Comprehensive Final and Lab exam 3: 8-11am**	Place to be determined

[K]: Kandel, E.R., Schwartz, J.H., Jessell, T.M., Siegelbaum, S.A., Hudspeth, A.J. Principles of Neural Science. Fifth edition, McGraw-Hill, 2013.
[M]: Martin, J.H. Neuroanatomy. Text and Atlas. Fourth edition. McGraw-Hill, 2012. °

° *Study questions after the assigned reading in Martin are well worth your time. A key is in the back of the book.*

EXAMINATION SCHEDULE

Class Exams

Sept. 22 (lec 1-7)	2050 VLSB	7pm
Oct. 15 (lec 8-14)	145 Dwinelle	7pm
Nov. 5 (lec. 15-20)	100 GPB	7pm
Dec. 3 (lec 21-26)	in class	

Laboratory Exams

Sept. 30	145 Dwinelle	7pm
Oct. 28	145 Dwinelle	**6pm***
Lab exam 3 is included in the Final		

Final Examination
December 18

Holidays
November 26

* note unusual start time

LABORATORY SCHEDULE

dates	*Lab topics*	*pages*
9/1, 9/3	1. Introduction to neuroanatomy: human and sheep brain I	7
9/8, 9/10	2. Sheep brain dissection: II	29
9/15, 9/17	3. Sheep brain dissection: III	45
9/22, 9/24	4. Neurocytology	55
9/29 10/1	5. Rat Brain I: Spinal cord to medulla	91
10/6, 10/8	6. Rat Brain II: Pons to diencephalon	115
10/13, 10/15	7. Rat Brain III: Basal ganglia/hippocampus/telencephalon	141
10/20, 10/22	8. Special senses: Cow eye dissection and slides	163
10/27, 10/29	9. Immunohistochemistry for calcium binding proteins	181
11/3 11/5	10. NADPH-diaphorase staining/mounting sections	201
11/10, 11/12	11. Mounting, dehydration, clearing coverglass	205
11/17, 11/18	12. Study of lab generated histology	209
11/25, 11/27	*No Lab this week (Thanksgiving holiday)*	•••
12/2, 12/4	13. Revisiting the gross brain*	223

* This week's lab will not count on lab exam 3 - it's just for fun and a chance to apply all you've learned to a fresh look at human and sheep brain specimens

Student Honor Code

The student community at UC Berkeley has adopted the following Honor Code:
"As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others." The hope and expectation is that you will adhere to this code.

Collaboration and Independence: Reviewing lecture and reading materials and studying for exams can be enjoyable and enriching things to do with fellow students. This is recommended. However, unless otherwise instructed, homework assignments are to be completed independently and materials submitted as homework should be the result of one's own independent work.

Cheating: A good lifetime strategy is always to act in such a way that no one would ever imagine that you would even consider cheating. Anyone caught cheating on a quiz or exam in this course will receive a failing grade in the course and will also be reported to the University Center for Student Conduct. In order to guarantee that you are not suspected of cheating, please keep your eyes on your own materials and do not converse with others during the quizzes and exams.

Plagiarism: To copy text or ideas from another source without appropriate reference is plagiarism and will result in a failing grade for your assignment and usually further disciplinary action. For additional information on plagiarism and how to avoid it, see, for example: http://gsi.berkeley.edu/teachingguide/misconduct/prevent-plag.html

Academic Integrity and Ethics: Cheating on exams and plagiarism are two common examples of dishonest, unethical behavior. Honesty and integrity are of great importance in all facets of life. They help to build a sense of self-confidence, and are key to building trust within relationships, whether personal or professional. There is no tolerance for dishonesty in the academic world, for it undermines what we are dedicated to doing – furthering knowledge for the benefit of humanity.

Your experience as a student at UC Berkeley is hopefully fueled by passion for learning and replete with fulfilling activities. And we also appreciate that being a student may be stressful. There may be times when there is temptation to engage in some kind of cheating in order to improve a grade or otherwise advance your career. This could be as blatant as having someone else sit for you in an exam, or submitting a written assignment that has been copied from another source. And it could be as subtle as glancing at a fellow student's exam when you are unsure of an answer to a question and are looking for some confirmation. One might do any of these things and potentially not get caught. However, if you cheat, no matter how much you may have learned in this class, you have failed to learn perhaps the most important lesson of all.

Signature Date

GENERAL INSTRUCTIONS FOR THE LABORATORY

Practical issues:

Sign up for only one lab section. You must get approval from your the GSIs to attend another session if a scheduling conflict arises, and then only if room capacity permits.

Notes on dissection

» Wear gloves whenever handling the brain, or objects that the brain may have touched. There are potential pathogens which are not neutralized by formalin and that may remain functional in fixed brain tissue.

» When starting on a brain that still has the dura intact, examine it carefully to observe the details that are visible. You should be able to see the largest of the cranial nerves, the trigeminal (V) as well as the olfactory bulbs (I) and pituitary gland. On the ventral aspect, open the dura carefully in order in order to preserve as many cranial nerves as possible. Using forceps and fine scissors, lift the dura and cut any linear structures that might be a nerve penetrating the meninges.

» Bisect the brain sagittally to observe the midline structures.

» Wet the brain each half hour with the water-alcohol solution (pink spray bottles) to prevent desiccation and control odor.

» At the end of each day's dissection, dispose of gloves and brain material in the appropriate containers.

» Wash your dissection tools and pans and leave to dry.

» A simple way to approach a dissection is to first identify every superficial structure, then to cut a slab about 3-5 mm thick, and identify every concealed structure with reference to surface features. When this is done, cut another slab and continue the process, while retaining each slab and "re-assembling" them in their proper sequence as you continue. Identify means this: what part of the brain it is in, its connections, its physiology, and the effect of a lesion to it.

» For deep dissections and to isolate fiber tracts, use a blunt probe or dissecting stick to gently abrade surface structures.

» The right-hand margin in each exercise is for notes, sketches, and questions.

Handling slides and microscope

» The microscopic slides assigned to your care are handmade and delicate. They require your care and consideration so that they will be available to those who follow you.

» Please handle them carefully. Replace them in order in your slide box when not in use.

» Please remove them from the microscope when your studies are completed. Unnecessary exposure to light bleaches the sections and reduces microscopic contrast.

» Please do not place slides on the countertop; rather, lay them out on the inside surface of the opened slide box.

» As you rotate your microscope turret, please check the clearance between slide and lens before moving the lens into place.

» If you wish to use a high magnification lens requiring oil immersion, please ask for assistance to avoid damaging lenses and slides. Oil immersion lenses have a black ring near their front and are typically 100x.

» When finished with the microscope, always turn the lamp intensity to zero before turning it off and put the low power objective (4x) in the home position.