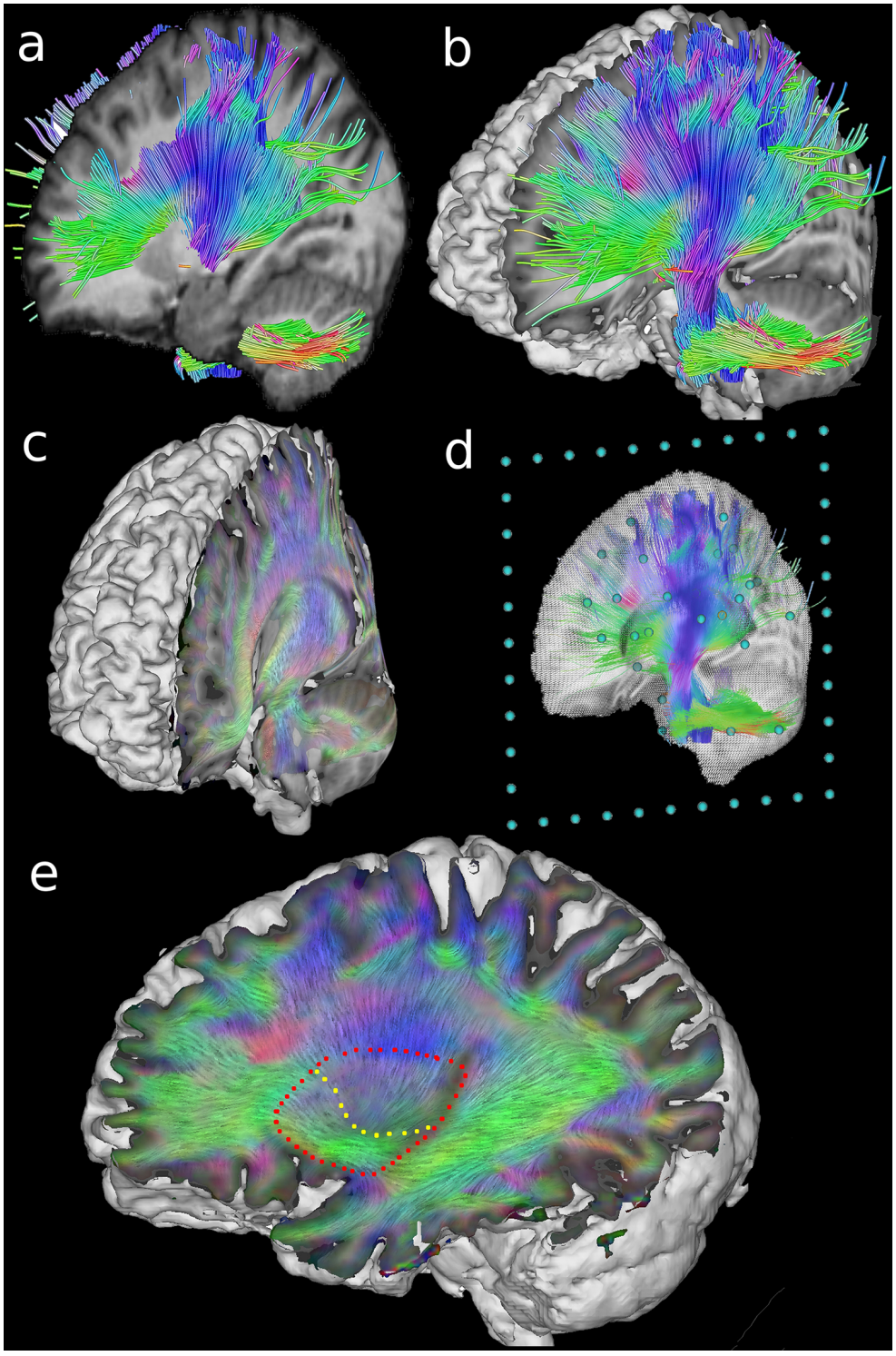
MAMMALIAN NEUROANATOMY



David Larue and Henk Roelink
Fall, 2013

University of California at Berkeley
Molecular and Cell Biology 163

Table of Contents

Preface

This course provides you with a basic understanding of the principles of brain function. These concepts will be useful in graduate or medical studies, and they can refine your ideas about biological complexity and order. The class will 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 for a global perspective on modern neuroscience.

Cover

Virtual Klingler Dissection: Visualizing white matter fiber bundles in the embedding tissue. In general, white matter fiber tractography from diffusion tensor imaging (DTI) is visualized as 3D lines or tubes together with 2D anatomical MR slices or surfaces. However, visualizing the exact location of the fiber tracts in their surrounding anatomy is still unsolved. We propose a virtual Klingler dissection method of brain white matter creating curved dissection surfaces locally parallel to user specified fiber bundles. Diffusion texturing of this surface provides new insight in the white matter fiber architecture. Procedure: a specific fiber bundle and an initial anatomical slice is selected (a); a spline surface is matched to fibers (b); the curved dissection plane is textured with the fiber orientation (c); control points of the spline surface for interactive optimization of the final shape (d). The color-coded diffusion texture shows fine anatomical details of the local tissue orientation of the sub-insular white matter (e). Alfred Anwander, Ralph Schurade, Mario Hlawitschka, Gerik Scheuermann, Thomas R. Knösche; *Max Planck Institute for Human Cognitive and Brain Sciences,* Leipzig, Germany.

Dedication ~ 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. We also want to thank Katie Dorsch Smith of the Feldman lab for help preparing 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 INTRODUCTION
Mammalian Neuroanatomy
4 units
https://bspace.berkeley.edu/

Class:	Tuesday and Thursday, 12:30-2:00 p.m.
Location:	Room 101 Barker
Laboratory:	Tuesday, 10:00-12:00 p.m. (section 103)
	Tuesday, 2:30-4:30 p.m. (section 101)
	Thursday, 10:00-12:00 p.m. (section 104)
	Thursday, 2:30-4:30 p.m. (section 102)
Location:	Room 4048 Valley Life Sciences Building

Instructor:	David Larue <dtlarue@berkeley.edu>
Phone:	642-9637
Office:	398 Life Sciences Addition
Office Hours:	Friday 2:00 p.m.- 4:00 p.m.
Instructor:	Henk Roelink, <roelink@berkeley.edu>
Phone:	642-5108
Office	21A Koshland (down the stairs, right)
Office Hours:	Friday 1:00 p.m. to 3:00 pm
GSI's	Eric Weiss <eaweiss@berkeley.edu>
	Amy Lemessurier <a.lemessurier@berkeley.edu>
Office Hours:	Tuesday and Thursday, 4:30-5:30 p.m.; 4048 VLSB

Required texts

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. 21st edition, 2013. The printed lab manual/syllabus contains only 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 bSpace. This makes for a more affordable and portable lab manual.

Course policies

1. The lectures presume that you have done the assigned reading.
2. Examinations
   - A. No makeups* – a 5 page research paper will be required to substitute for any missed classroom or laboratory exam – *the best score possible will be the mean obtained by the class on the missed exam*
   - B. Adjustments on test scores must be negotiated with your GSIs – with input from the instructors if necessary
   - C. First two laboratory exams are timed, powerpoint format - 3rd lab exam is written question format.
   - D. Lecture exam format consists of short essays, matching, true/false and multiple choice format
   - E. Review sessions can be arranged with your GSIs
   - F. Course is graded on a percentage scale - not a fixed curve The weighting of the examinations is:

Classroom exams (3 @ 15% each of final grade)	: 45%
Classroom final (1 @ 25% of final grade) cumulative but stresses last quartile of course	: 25%
Laboratory examinations (3 @ 10% each of the final grade)	: 30%
Total:	100%

3. Attendance in laboratory sessions is **not optional**. A laboratory missed for a medical reason (illness, etc.) can be made up through arrangement with your GSI. A make-up lab requires a written excuse from a relevant health professional on their letterhead within one week. Labs missed for other than medical 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. 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. Lectures in pdf format will be posted on bSpace (before class, usually).

* Exams (classroom or laboratory) can be missed for medical reasons only and require a written excuse from a physician or a professional at the campus health center. If you miss a test, contact your GSI immediately to be assigned a topic on which to write a five-page research paper whose content must be entirely yours and original. You have one week to complete this paper. Maximum credit for a paper substituting for a missed exam will be the mean score obtained by the class.

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Teaching staff

1. David Larue, Lecturer in Neurobiology

• Scholarly interests and backgraound:

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 surgery, 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; Mammalian Neuroanatomy (MCB 163) and Neurobiology Lab (MCB 160L) here at Berkeley

2. 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. He further teaches genetics and animal development to graduate and undergraduate students. He likes to teach anatomy from a developmental perspective.

3. Eric Weiss, graduate student in the Olshausen lab (Helen Willis Neuroscience Institute). Eric did his undergraduate work at UC San Diego.

• Scholarly interests: Eric is studying the computational principles that underlie the brain's ability to infer the state of the body and environment, and how this inference process is learned through experience.

4. Amy Lemessurier, graduate student in the Feldman lab (Helen Willis Neuroscience Institute). Amy did her undergraduate work at MIT.

• Scholarly interests: Amy is interested in how we form complete contextual representations of the world through sensory encoding. Specifically, she studies somatosensory encoding in the rodent whisker system.

Disabled students program (DSP)

• Please contact the instructors if you are taking this course with 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. The list of terms in 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 bSpace in a printable format, if you desire a hard copy.

MCB 163 ~ LECTURE SCHEDULE

DATE	INSTRUCTOR	LECTURE ~ TOPIC	READING
August 29	Larue	(1) Organization of the brain	M 3-26 57-82; K 5-18, 337-354
September 3	Larue	(2) Neurocytology	K 21-38, 72-97
September 5	Roelink	(3) Developmental neuroanatomy	K 1165-1230
September 10	Larue	(4) Spinal cord	M 227-251; K 790-810
September 12	Roelink	(5) Dorsal column system (touch)	M 85-103; K 498-527
September 17	Roelink	(6) Spinothalamic system (pain)	M 107-123; K 530-553
September 19	Roelink	(7) Neuroanatomy web resources	URLs in the presentation
September 24		**Lecture Exam #1 (in class)**	•••
September 26	Larue	(8) Cerebellum	M 299-324; K 960-979
October 1	Larue	(9) Cranial nerves I: overview	K 1019-1036; M 255-273
October 3	Roelink	(10) Cranial nerves II: Trigeminal complex	M 127-151; K 1019-1036
October 8	Roelink	(11) Control of muscle and movement	M 127-148; K 835-892
October 10	Roelink	(12) Basal Ganglia	M 325-348; K 982-998
October 15	Larue	(13) Neuropathology	K 307-329, 999-1012, 1425-1439
October 17	Larue	(14) Vestibular system/**Lecture Exam #2***	M 277-295; K 917-933
October 22	Larue	(15) Auditory system I: receptors/transduction	K 654-680
October 24	Larue	(16) Auditory system II: central pathways	M 181-196; K 682-710
October 29	Roelink	(17) Visual system I: the eye/retina	K 577-600
October 31	Larue	(18) Visual system II: central pathways	K 602-619
November 5	Larue	(19) Thalamus	M 45-48; K 360-368
November 7	Roelink	(20) Gustation/olfaction /**Lecture Exam #3***	M 201-220; M 712-134
November 12	Larue	(21) Cerebral cortex and corticofugal pathways	M 29-54; K 337-354, 392-410
November 14	Roelink	(22) Neural basis for speech and language	K 1353-1371
November 19	Roelink	(23) Hippocampus, the ancient cortex	M 217, 385-394; K 1487-1518
November 21	Roelink	(24) Hypothalamus: autonomic nervous system	M 355-383; K 961-981
November 26	Roelink	(25) Limbic system	M 385-411; K 1487-1518
November 28		**Holiday**	
December 3	Larue	(26) Chemical neuroanatomy	K 1038-1054
December 5	Larue/Roelink	(27) Review/synopsis	

*** Evening exam**

[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.*

schedule pending: **Final Examination**
location and time to be announced

EXAMINATION SCHEDULE

Class Exams	Laboratory Exams		Final Examination	Holidays
September 24 (lec 1-7)	October 2	8pm, 100 GPB	To be announced	November 28
October 17 (lec 8-13)	October 30	8pm, 100 GPB		
November 7 (lec 14-19)	December 4	8pm, 100 GPB		

LABORATORY SCHEDULE

dates	*Lab topics*	*pages*
9/3, 9/5	1. Introduction to neuroanatomy: human and sheep brain I	7
9/10, 9/12	2. Sheep brain dissection: II	29
9/17, 9/19	3. Sheep brain dissection: III	45
9/24, 9/26	4. Neurocytology	57
10/1 10/3	5. Rat Brain I: Spinal cord to medulla	93
10/8, 10/4	6. Rat Brain II: Pons to diencephalon	117
10/15, 10/17	7. Rat Brain III: Basal ganglia/hippocampus/telencephalon	143
10/22, 10/24	8. Special senses: Cow eye dissection and slides	165
10/29, 10/31	9. Immunohistochemistry for calcium binding proteins	183
11/5, 11/7	10. NADPH-diaphorase staining/mounting sections	203
11/6, 11/8	11. Mounting, dehydration, clearing coverglass	207
11/19, 11/21	12. Study of lab generated histology	213
11/26, 11/28	*No Lab this week (Thanksgiving holiday)*	•••
12/3, 12/5	13. Revisiting sheep brain dissection	227

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 cannot are not neutralized by formalin and that may remain functional in fixed brain tissue.

» If the brain still has the dura intact, remove it carefully in order to see the trigeminal nerve (V) and other structures like the pituitary gland, that will come away with the outer meningeal layer.

» Bisect the brain sagittally to observe the midline structures.

» Wet the brain each half hour with the water-alcohol solution to prevent desiccation and control odor.

» Store the brain in the container with your name marked on it.

» 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 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.