California State University, Los Angeles
School of Natural and Social Sciences
Department of Biological Sciences
WINTER, 2011

Course title, number and units: Neurobiology: Neuroanatomy, Biology 435 (4)

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Class Location: PS 233
Time: TR 9:50-11:30 AM
Office hours: M 1:30-2:30; TR 11:30-12:00

Description: Neurobiology: Neuroanatomy is a course designed to introduce the student to the gross and microscopic structure of the mammalian nervous system, its organizational aspects, classical lesions and deficits. Both clinical and neuroscience research correlates will be included in this course, with student participation.

Prerequisite: Biol 380 or equivalent

Course Requirements:

Textbook: Martin, John H. (2003) Neuroanatomy. Text and Atlas, Third Edition. New York: McGraw-Hill.
You are expected to read the assigned chapter before each class (refer to the course schedule and syllabus).

Optional Supplementary Material: Young, Paul A. and Young, Paul H. (1997) Basic Clinical Neuroanatomy. Baltimore: Williams and Wilkins.
This textbook can be used for clinical correlations to be covered during the latter third of each class period.

Participation in Clinical or Basic Research Correlations: In groups of 4, students will prepare and lead the discussion of a clinical case or a neuroscience research approach. Detailed instructions about the presentation are provided at the end of this syllabus. Presentations will take place during the latter half of class periods from January 18th through March 8th. Sign ups will take place on Tuesday, January 11th.

Attendance: Students are responsible for all material presented in class, including announcements about changes in course procedures.

On planning your time, a fair calculation should take into account the need to spend at least 2 hours of independent study for each class hour.

Evaluation:

Tests: There will be two exams. The tests will be a combination of short answer, matching/multiple choice and essay questions. I feel this testing format is the best way to allow an individual to demonstrate his or her understanding of the subject, and does allow for partial credit. The final exam will be comprehensive. No make-up tests will be scheduled. With an excused (i.e. discussed in advance or doctor's note) absence for a test, the value of the final exam will be increased to compensate for the missed test. If evidence of emergency can be provided for a missed final (in the case of no other missed exams or presentation), an Incomplete will be given.

Quizzes: Each lecture period may begin with a short (one question – 5 minutes) blue book quiz which will cover a central concept from the required reading. The question will be easily answered if the student has done a general (initial) reading of the material to be covered that day. At the end of the quarter the lowest score (or one missed quiz) will be dropped, and the remainder will be combined to count for 10% of the total grade for the course.

Grading:		
	Midterm	25%
	Quizzes	10%
	Class Presentation	25%
	Final Exam	40%

Grades in this course are not curved. Course grades will be assigned as follows:

A:	90% - 100%
A-:	88% - 89%
B+:	86% - 87%
B:	79% - 85%
B-:	77% - 78%
C+:	75% - 76%
C:	65% - 74%
C-:	61% - 64%
D+:	56% - 60%
D:	47% - 55%
F:	below 47%

Academic Honesty: Students are expected to read and abide by the University's Academic Honesty Policy, which can be found at www.calstatela.edu/academic/senate/handbook/ch5a.htm. Students who violate this policy will be subject to disciplinary action, and may receive a failing grade in the course for a single violation.

Office Hours and General Advice:

For questions and assistance regarding class material, please make an appointment with me in person or e-mail for one of my office hour slots. The times posted on the first page of this syllabus have been set aside for this class.

For general advisement issues, please make an appointment to see me via the Biology Department Office at (323) 343-2050. The following hour has been set aside for general advisement: Mon 10:30-11:30 AM.

If you put in the effort required, you should learn a lot from this course. Quite a bit of material is covered in a short time. If you are having trouble, or are not learning what you hoped to learn, speak to me. While assisting you, I also benefit from your feedback.

Course Schedule:

THE CENTRAL NERVOUS SYSTEM (CNS): An Introduction

TUES	1/4	Introduction	Ch 1
THUR	1/6	Overview of the Nervous System	Ch 1
TUES	1/11	Organization of the Central Nervous System Presentation sign-ups Clinical/Research: Imaging of the CNS	Ch 2

THUR	1/13	Vasculature of the CNS, and Cerebrospinal Fluid Clinical Corr: Stroke	Ch 4
TUES	1/18	The Somatic Sensory System Clinical Corr: Disorder of this system (Anesthesia and Analgesia)	Ch 5

SENSORY SYSTEMS

TUES	1/20	The Visual System Clinical Corr: Anopsia	Ch 7
THUR	1/25	The Auditory and Vestibular Systems Research Corr: Lesion Studies of the CNS	Ch 8, 12
THUR	1/27	The Gustatory, Visceral Afferent, and Olfactory Systems Research Corr: Neurotransmitter System Labeling	Ch 9/6
TUES	2/1	Review for midterm exam	
THUR	2/3	Midterm exam: Introductory material, sensory systems and clinical corr.	

MOTOR SYSTEMS

TUES	2/8	The Descending Projection Systems and the Spinal Cord Clinical Corr: Paralysis	Ch 10
THUR	2/10	The Cerebellum Clinical Corr: Ataxia	Ch 13
TUES	2/15	The Basal Ganglia Clinical Corr: Movement Disorders	Ch 14
THUR	2/17	No Class	

THE BRAIN STEM

TUES	2/22	The Cranial Nerve Nuclei and the Trigeminal System Research Corr: Anterograde and Retrograde Labeling	Ch 6
THUR	2/24	Motor Functions of the Cranial Nerves I	Ch 11
TUES	3/1	Motor Functions of the Cranial Nerves II Clinical Corr: Cranial Nerve Lesions	Ch 12

INTEGRATIVE SYSTEMS

THUR	3/3	The Hypothalamus and the Regulation of Endocrine and Visceral Functions Clinical Corr: Vegetative and Endocrine Imbalance	Ch 15

TUES	3/8	The Limbic System Clinical Corr: Anterograde Amnesia and Inappropriate Behavior	Ch 16
THUR	3/10	General Review	
THUR	3/17	**Final Examination** **8:00 – 10:30**	

Syllabus:

1 Introduction to the Nervous System

In this lecture, the organization and characteristic surface features of the nervous system are surveyed, to establish a working knowledge of the structure and the vocabulary necessary to study its functional and regional organization.
CONTENTS: Cellular constituents of the CNS (microscopic anatomy); Overview of the nervous system: CNS and PNS; The 7 major divisions of the CNS and their key components; An introduction to neuroanatomical orientation terms.
READINGS: Neuroanatomy, Ch. 1.

2 Organization of the Central Nervous System

The complex three-dimensional organization of the central nervous system is reflected in its developmental plan. Here we begin to focus on the internal organization of the central nervous system by introducing 2 fundamental neural systems that course the entire neuraxis: The dorsal column-medial lemniscal system and the corticospinal tract. We will overview these systems “from the bottom up” (from spinal cord to cerebral hemispheres), comparing the three-dimensional configuration of brain structures with their appearance in histological sections, which are two-dimensional slices.
CONTENTS: Longitudinally oriented systems: The dorsal column-medial lemniscal system and the corticospinal tract; The spinal cord and brainstem; The thalamus; The laminar organization of the cerebral cortex; Neurotransmitter-specific (diffuse) projections in the CNS. Clinical notes: Imaging of the CNS.
READINGS: Neuroanatomy, Ch. 2.

3 Vasculature of the CNS, and Cerebrospinal Fluid

Continuous blood supply to the CNS is vital, as glucose and oxygen are needed continuously for function, and neither is stored in significant amounts. Not surprising, diseases of brain vasculature constitute one of the major classes of disease affecting the CNS. In this lecture, we will overview the major arterial supply of the CNS from the point of view of major sources: The anterior (carotid) and posterior (vertebral) systems. Once again, we will review this system from the bottom (spinal cord), all the way up to the cerebral cortex. We will also overview the venous system (designed to quickly return blood to the heart from the brain), the blood-brain barrier, and the production and function of cerebrospinal fluid (CSF).
CONTENTS: Arterial supply to the CNS: The anterior and posterior systems; Connections between anterior and posterior systems (anastomoses); Venous drainage and the dural sinuses; The blood-brain barrier; CSF. Clinical notes: Stroke.
READINGS: Neuroanatomy, Ch. 4.

4 The Somatic Sensory System

The sensory systems of the brain are the focus of this and the next 4 lectures. Here we consider the anatomical organization of the somatic sensory system, which processes stimuli that impinge on the body surface (skin, mucous membranes), or originate within the body (muscle, joints and viscera). We will review the functional organization of this system that serves the sense of touch, limb position, pain and temperature for the trunk and limbs (the trigeminal system, which transmits somatic sensory information for the head, has a similar organization, but will be discussed later when we study the cranial nerves). We will also discuss the regulation of arousal and the sensory regulation of movement.
CONTENTS: Functional anatomy of 2 primary somatic sensory pathways: The dorsal column-medial lemniscal system and the anterolateral system. Regional anatomy: following the course of these systems all the way from the sensory receptors to the brain: Structure of peripheral receptors; Entry and initial pathways of dorsal root axons in the spinal cord; Pathway through the brainstem; Projections to the reticular formation; Thalamic nuclei; The primary somatic sensory cortex and its organization; Secondary (higher order) somatic sensory cortical areas. Clinical correlation: Anesthesia/analgesia.
READINGS: Neuroanatomy, Ch. 5.

5 The Visual System

Visual perception is a complex process that uses "outpouchings" of the CNS (the retinae) as the sensory organs to process visual information from the surroundings and project it to the primary visual cortex in the occipital lobe. Visual perception is not a passive process in which the eyes simply receive visual stimulation. Rather, the position of the eyes is precisely controlled in order to scan the environment and to attend selectively and orient to specific visual stimuli. Therefore, in this lecture we will examine the two anatomically separated pathways that mediate visual perception and oculomotor control. As we review the regional anatomy of visual perception, we will also discuss retinotopic organization at various levels. Spatial organization of visual information within the retina is retained all the way to the primary visual cortex, and is reflected in columnar organization of the cortex.
CONTENTS: Functional anatomy: Overview of the 2 primary visual paths (for visual perception and control of eye movements). Regional anatomy: Structure of the eye; Cellular structure and connections within the retina; The optic nerve and optic chiasm; the superior colliculus; The lateral geniculate nucleus of the thalamus; Optic radiations and projections to the primary visual cortex; Inputs to higher-order visual cortical areas; Visual field defects after damage to the visual system at various levels. Clinical correlation: Anopsia.
READINGS: Neuroanatomy, Ch. 7.

6 The Auditory and Vestibular Systems

The auditory system mediates the sense of hearing. The vestibular system contributes to the sense of balance. In this lecture we will consider the general organizational plan of both systems and we will examine key levels in which structures that process auditory and vestibular information are located.
CONTENTS: Functional anatomy of these two systems: Overview of the way that sound waves or physical motion of the head is transduced into neural signals and projected to the cerebral cortex: Parallel ascending auditory pathways and ascending vestibular system. Regional anatomy: Structure of the ear and cochlear organ; Vestibular senory organs; Brainstem nuclei; Lateral lemniscus; Inferior colliculus; Medial geniculate nucleus of the thalamus; Primary auditory cortex; Wernicke's area—a higher order auditory cortex. Research presentation: Lesion studies of the CNS.
READINGS: Neuroanatomy, Ch. 8, 12.

7 The Gustatory, Visceral Afferent, and Olfactory Systems

The chemical senses, taste and smell, are mediated by four cranial nerves. Although anatomically separate, gustatory and olfactory systems work jointly in perception of

certain chemical stimuli, for example complex flavors such as vanilla. In addition, the system for monitoring the body's "internal state", or autonomic function, is anatomically associated with the gustatory system. Therefore, we will discuss the gustatory and visceral afferent systems together. We will examine first the general organization of each system, before studying the brain regions that process gustatory and olfactory stimuli.
CONTENTS: Gustatory and visceral afferent systems: Sensory organs (i.e. chemoreceptors) and cranial nerve branches; Solitary nuclear complex; thalamic projection for the gustatory system; Primary cortical gustatory areas (frontal operculum and anterior insular cortex). Olfactory system: Overview and special features of this system (i.e. direction projection without thalamic relay, primary cortex is allocortex); Olfactory neurons in nasal mucosa; Olfactory bulb; Primary olfactory cortex (Five distinct brain areas with different functions). Research presentation: Neurotransmitter system labeling.
READINGS: Neuroanatomy, Ch. 9, 6.

8 **Descending Projection Systems and the Motor Function of the Spinal Cord**

The motor system consists of those parts of the brain and spinal cord that control skeletal muscle. There are four anatomically separate components of the motor system. We will examine two of those components in this lecture (cortical and spinal motor neurons) and the other two components in the next lectures (cerebellum and basal ganglia). Note: Our "tours" through various motor systems will go in the opposite direction of what we experienced with sensory systems (from the cerebral cortex down to motor neurons in the spinal cord, rather than from bottom up). This is in tune with the direction that signals are carried in the living brain.
CONTENTS: Functional anatomy: Components of the motor systems of the CNS; Organization and function of the descending pathways (i.e. lateral/medial). Regional anatomy: Motor regions of the cerebral cortex: Premotor (higher order) cortical regions; Primary motor cortex; Descending projection forming the corticospinal tract; Organization of the corticospinal tract in the midbrain and various regions of the brainstem; Input from descending pathways within the spinal cord and topographic organization of the grey matter and white matter; Notes about lesions of the descending cortical pathway. Clinical correlation: Paralysis.
READINGS: Neuroanatomy, Ch. 10.

9 **The Cerebellum**

This lecture will deal with the third component of the motor system, the cerebellum, involved in motor coordination. Because the three-dimensional organization of the cerebellum is so complex, we will consider the gross anatomy first and then its functional organization.
CONTENTS: The gross anatomy of the cerebellum: Major divisions; Cerebellar peduncles; Folia; Deep cerebellar nuclei. Functional anatomy: 3 major functional divisions of the cerebellum: Spinocerebellum, Cerebrocerebellum and Vestibulocerebellum. Regional anatomy: Cytoarchitecture and circuitry of the cerebellar cortex; Cerebellar-associated nuclei of the spinal cord and brainstem; Organization of the fiber pathways that link the cerebellum to the rest of the brain; The VL nucleus of the thalamus; Clinical notes regarding cerebellar lesions. Clinical correlation: Ataxia.
READINGS: Neuroanatomy, Ch. 13.

10 **The Basal Ganglia**

This lecture will introduce the fourth component of the motor system, a collection of subcortical nuclei involved in sensory-motor integration, affective behavior and cognitive functions.
CONTENTS: Functional anatomy: Input and output components of the basal ganglia; Parallel circuits of information flow through the basal ganglia; Neurotransmitters; Intrinsic circuitry of the basal ganglia; Movement disorders. Regional anatomy: Internal capsule

and striatum; Coronal sections revealing anatomical relationships of the various nuclei; The substantia nigra. Clinical correlation: Movement disorders.
READINGS: Neuroanatomy, Ch. 14.

11 General Organization of the Cranial Nerve Nuclei and the Trigeminal System

The anatomical systems that process sensory information from the head are separate from those that process information from the trunk and limbs (although the general features of their organization are very similar). In this lecture we will introduce the 12 cranial nerves, their location and function, and discuss the organization of the cranial nerve nuclei. We will then review the functional and regional anatomy of the trigeminal system, which processes sensory information from the face.
CONTENTS: Intro to the cranial nerves and nuclei: The 12 cranial nerves, their location and function; Categories of cranial nerves, and the columnar organization of their nuclei. Functional anatomy of the trigeminal system: Ascending pathway for touch (using the main trigeminal sensory nucleus); Ascending pathway for pain and temperature (using the spinal trigeminal nucleus). Regional anatomy: Key components of the trigeminal system within the brainstem; Midbrain anatomy; Thalamic projections to the primary somatic sensory cortex; Somatotopic organization. Research presentation: Anterograde and retrograde labeling.
READINGS: Neuroanatomy, Ch. 6.

12 The Somatic and Visceral Motor Functions of the Cranial Nerves

We have seen that the function and key features of the trigeminal system parallel those of the spinal cord ascending system. In this lecture we will consider that a similar comparison can be made between motor control of cranial structures and those of the trunk and limbs. We will further examine the organization of three functional categories of cranial motor nuclei to obtain an in-depth understanding of brain stem anatomy, which is essential for clinical problem solving.
CONTENTS: The 3 classes of cranial nerve motor nuclei and their columnar organization; Cortical control of cranial motor function: The corticobulbar tract; Cortical areas involved in eye movement control; The general somatic motor cell column; The special visceral motor cell column; The general visceral motor cell column and the parasympathetic system. Clinical correlation: Cranial nerve lesions.
READINGS: Neuroanatomy, Ch. 11, 12.

13 The Hypothalamus and the Regulation of Endocrine and Visceral Functions

The hypothalamus, the other part of the diencephalon that we have not yet discussed, plays a crucial role in maintaining normal organ function. The hypothalamus serves three major functions that ensure survival of the individual and of the species: 1) regulating release of hormones from the pituitary gland, 2) regulating the autonomic nervous system (the 'general visceral motor' function reviewed in last lecture), and 3) regulation of "appetitive behaviors" (eating, drinking and mating). The first two of these functions will be discussed in lecture today (the third is part of the limbic system, and will be discussed in the next and final lecture).
CONTENTS: Introduction to the three functional (mediolateral) zones of the hypothalamus, and the nuclei contained; Regulation of the pituitary gland: Parvocellular (anterior) and Magnocellular (posterior) neurosecretory systems; Overview of autonomic nervous system functional anatomy (sympathetic, parasympathetic systems); Regulation of autonomic function by descending projections from the hypothalamus; Regional anatomy: Review of the functional zones and key nuclei in sections. Clinical correlation: Vegetative and endocrine imbalance.
READINGS: Neuroanatomy, Ch. 15.

14 The Limbic System

The limbic system includes regions of the cerebral hemispheres that collectively mediate emotion and the behavioral expression of emotion. Anatomically, the term

"limbic" refers to a "C" shaped area surrounding the diencephalon (limbus = border) and bordering the cerebral cortex. In this lecture we will survey the various components of the limbic system, its connections and functional organization. Important components include the hippocampal formation, amygdala, cingulate and parahippocampal cortices. These brain areas are key to learning, memory and behavior (including emotional behavior), and are important for the study of psychiatry.
CONTENTS: Anatomical location and overview of components of the limbic system; Structure and function of the hippocampal formation; The amygdaloid nuclear complex, and the function of its 3 components; Links between the limbic system and effector (behavior) systems; Links between neurotransmitter-specific projection systems and the limbic system; Regional anatomy of these structures. Clinical correlation: Anterograde amnesia and inappropriate behavior.
READINGS: Neuroanatomy, Ch. 16.

Required Presentation for Clinical Correlation or Basic Research Correlation:

As noted above, you will be required to actively participate in presentation of one clinical case example, or one research approach during a class period between January 18th and March 8th. A team of four students will prepare each presentation. Sign-ups for teams, presentation times and topics will take place early in the course (third class-January 11th).

Clinical Case Presentation
In order to prepare a clinical presentation, find information about the chosen disorder and answer these questions:

1. What CNS structure(s) is/are involved in this disorder, how is neuronal circuitry altered, and what abnormalities result?

2. What are the cardinal manifestations of this disorder? What are the clinical findings? What tests, if any, are used to establish the diagnosis?

Next, choose a clinical example (either real or fabricated), and write a formal description (in SOAP format):

S: Subjective

Description of the patient and his/her presentation, and the symptoms experienced ('History of Present Illness')

O: Objective

Signs found during physical examination, and the results of any diagnostic tests

A: Assessment

Differential diagnosis, given the data presented above (for our purposes, we will focus on the assigned disorder—which will be the most likely diagnosis)

P: Plan

Treatment plan: What treatment or support strategy will be provided to the patient?

Your actual **presentation** will give the class this information (in "SOAP" format, or the reverse order of your research, above):

1. Start with the clinical example: Describe the patient's presentation ('Subjective', above)
2. Provide the background information about the clinical manifestations of the disorder or syndrome.
3. Describe the clinical findings and tests in your example case ('Objective', above), and any treatment or support for the patient ('Plan')
4. Finish the presentation with a description of the neurobiology of the disorder (Structures involved, alterations in neuronal circuitry, etc.)

Each individual in the four student "team" will cover one of the four items above.

Presentation time: 30 minutes will be provided for the presentation (20-25 minutes) and questions/answers or discussion with the class (5-10 minutes).

Prepare a **handout** for the class, including the formal clinical description (SOAP note) and illustrations of the clinical presentation (e.g. symptoms and signs) and the neurobiology (anatomical lesions, circuitry).

Basic Neuroscience Research Presentation

In order to prepare the presentation of a neuroanatomical research approach, find a clear description of the technique, and some historical background. You will also find a primary research study from the scientific or clinical literature to refer to as an example.

1. General description of the neuroanatomical technique, and historical background
2. What is the purpose of this technique? What types of questions is this method designed to answer in terms of how the brain functions, or how circuits are interconnected?
3. Description of an example study (method, results)
4. Discussion of the importance/significance of the results in your example

As above, each individual in the team of four students will present one of the items above. **Total presentation time** (including questions/answers or discussion with class): 30 minutes.

Handout: For this presentation, the handout will include the **description/background** for the technique, **illustrations** of the method and results, and description of the **significance** of the results in your example.