



## Basic Neuroscience Core Curriculum (Short Version)

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### Background

Neural science education in the first two years of medical school provides a foundation for neurology and psychiatry clerkship experiences in the clinical years as well as the ability to interpret neurologic findings in the context of medical or surgical practice. Indeed, 9% to 10% of primary care patient encounters involve neurologic complaints, which are likely to increase due to increased burden of degenerative neurologic disease in our aging population. Among hospitalized patients, those with neurologic conditions range from 5% to 19%. Neurologists comprise only 2% of US physicians (according to the American Medical Association's "Physician Characteristics and Distribution in the U.S.," 2001-2002 edition), and generalists provide initial management of most patients with neurologic disorders (Charles et al, 1999). It is therefore essential to provide a sound foundation in neural science and its application to human health and disease (Purpura, 2002).

An understanding of how the nervous system, external environment, and body interact to generate behaviors and diseases and how we might intervene in these processes necessarily draws on many classic basic science disciplines. Thus, within individual medical school curricula, neural science courses are often the first to adopt an interdisciplinary approach. In many cases, such courses have set standards for current medical education trends toward integrated curricula. Despite this national trend, no current curricular guidelines exist with which to develop or evaluate integrated neural science curricula.

A major advance in neurologic education towards the goal of curricular guidelines was the development of a neurology clerkship core curriculum by Gelb and colleagues (2002). The neurology clerkship core curriculum document was produced with the intention to provide clerkship directors and curriculum deans with a consensus recommendation regarding minimum desirable content for the neurology clerkship curriculum. The neurology clerkship core curriculum lists as a prerequisite a "preclinical curriculum of neuroanatomy, neurophysiology, neuropathophysiology, and physical diagnosis." The development of the neurology clerkship core curriculum provides a challenge to examine and develop the basic neuroscience component of the medical school curriculum to determine what body of knowledge, attitudes, and skills would be considered necessary as a foundation in neuroscience for optimal learning in the clinical years. The Undergraduate Education Subcommittee of the American Academy of Neurology (AAN) and the Association of Medical School Neuroscience Department Chairs (AMSND) recognized the need to delineate the basic science topics necessary for a firm neuroscience foundation for successful subsequent clinical educational experiences involving the neurology clerkship and clinical medicine in general. A combined task force consisting of four representatives of each organization was created to develop this curriculum.

### Goals of the Basic Neuroscience Curriculum

It is our goal to provide guidelines for the development, content and evaluation of neuroscience courses taught primarily in the first and/or second years of medical school. The guidelines are designed to prepare students for future neuroscience clerkship and practice experiences as well as to provide the background to participate in basic, clinical, and translational research in the neurosciences. It is hoped that the construction of such a content outline would help to facilitate integration of basic and clinical neuroscience and promote the inclusion of topics such as genetics, epidemiology and medical informatics (including critical thinking and analysis skills) early in the curriculum.

### Learning Objectives for Students

- Describe the normal structure and function of key components of the human nervous system and molecular, biochemical and cellular mechanisms required for health and homeostasis.
- Identify common disorders of the nervous system and describe the alterations in structure and functioning underlying diseases.
- Describe the complex interplay of the biological, psychological, and social factors in the genesis and maintenance of psychological health and disease and the nosology and phenomenology of psychiatric disorders.
- Demonstrate the ability to apply basic knowledge and principles in neuroscience (including neuroanatomy, neurophysiology, neuropharmacology, neuropathology, and behavioral science) to permit knowledgeable participation in the diagnosis and care of patients with neurologic and psychiatric disorders.
- Demonstrate skills of medical problem solving, communication, team work and life-long learning.

## **Techniques**

The task force met several times in person, held multiple teleconferences, and communicated by email. Sources that were considered in the development of this curriculum included the curricula of 10 schools with well-developed integrated neuroscience curricula for the first two years, consideration of prerequisites for a sound background to optimize the educational experience in the clinical-year clerkships (especially neurology, neurosurgery, and psychiatry), a review of topics covered by Step 1 and Step 2 of the United States Medical Licensing Examination™ (USMLE), solicitation of comment from educators from other schools, and a review of the literature.

## **Basic Neural Science Core Curriculum (Short Version)**

### **I. Neural Cell Biology**

- A. Cellular elements of the nervous system
- B. Divisions of the nervous system
- C. Neuronal morphology and cell biology
- D. Functional classification of neurons
- E. Glial cells
- F. Peripheral nerves
- G. Neuron electrical, excitable properties for signaling
- H. Synaptic transmission
- I. Trophic and growth factors
- J. Neurogenetics

### **II. Central Nervous System (CNS) Homeostasis**

- A. General metabolism
- B. Blood-brain barrier (BBB)
- C. Choroid plexus
- D. Cerebrospinal fluid (CSF)
- E. Hydrocephalus

### **III. Neural Development**

- A. Induction
- B. Patterning
- C. Neurogenesis
- D. Migration
- E. Differentiation
- F. Synaptogenesis
- G. Cell survival
- H. CNS embryology
- I. Peripheral nervous system (PNS) embryology
- J. Histology
- K. Cell types
- L. Dorsal-ventral development
- M. Myelination
- N. Disorders of development

### **IV. Functional Neuroanatomy**

- A. Basics
- B. Spinal cord
- C. Brainstem
- D. Diencephalon
- E. Cerebrum
- F. Sensory systems
- G. Motor systems
- H. Autonomic nervous system
- I. Limbic system and emotional behavior
- J. Cognition
- K. Language
- L. Memory
- M. Sleep

## **V. Clinical Assessment of Neurologic System**

- A. Neurologic examination
- B. Diagnostic tests

## **VI. Neuropharmacology and Other Therapeutic Modalities**

- A. Peripheral nervous system (PNS)
- B. Central nervous system (CNS)
- C. Nonpharmacologic therapeutic modalities

## **VII. Neuropathophysiology**

- A. Infectious, inflammatory, and immunologic disorders
- B. Traumatic and mechanical disorders
- C. Neoplastic disorders, including primary, metastatic, and paraneoplastic
- D. Acquired metabolic and regulatory disorders
- E. Vascular disorders
- F. Systemic disorders
- G. Congenital disorders, including metabolic
- H. Phakomatoses
- I. Degenerative disorders
- J. Paroxysmal disorders
- K. Pain syndromes
- L. Sleep disorders
- M. Movement disorders
- N. Dizziness and vertigo
- O. Disorders of special senses

## **VIII. Psychopathologic Disorders**

- A. Early-onset disorders
- B. Substance abuse disorders
- C. Psychotic disorders
- D. Mood disorders
- E. Anxiety disorders
- F. Somatoform disorders
- G. Personality disorders

## **Personnel Needed for Training**

- A. Essential personnel
  1. Course director or co-directors with adequate protected time and support to administer and teach the course (Some schools have co-directors from basic and clinical neuroscience backgrounds, respectively, to facilitate integration.)
  2. A course design team or a committee of topic division heads.
  3. Additional full-time instructional faculty in neuroscience, anatomy, physiology, pharmacology, pathology, neurology, psychiatry, ophthalmology, and otolaryngology.
  4. Adequate secretarial and administrative support for the course director(s).
- B. Desirable personnel
  1. Basic and clinical adjunct faculty.
  2. Involvement of neuroscience graduate students and neurology, neurosurgery, pathology, and other residents in teaching is often highly effective and beneficial to all parties.

## **Essential Learning Experiences**

An optimal neuroscience curriculum should include several different types of learning experiences to optimally present different types of information and to assist those with different types of learning styles. These might include:

- A. Didactic teaching sessions and formal lectures.
- B. Materials for independent study, such as textbooks, locally-generated syllabi, and web-based materials.
- C. Laboratories for brain dissection or study of prosections of the brain and spinal cord to reinforce the neuroanatomy taught in didactic sessions and correlative radiologic images.
- D. Other laboratory/skills sessions involving neurologic examination techniques, demonstrations of neurodiagnostic testing techniques, etc.

- E. Case presentations involving correlation between clinical presentation, pathologic lesion localization, and radiologic and/or electrophysiologic demonstration of pathology. This may be in the Problem-Based Learning (PBL), Team-Based Learning (TBL), or other approaches that emphasize active learning and problem-solving skills. Inclusion of live or videotaped patient presentations is essential to demonstrate the relevance to the practice of clinical medicine.
- F. Supervised patient care experiences at a level appropriate for the student to provide a clinical correlative experience.

### **Timetable for Training**

The optimal time necessary to cover the basic neuroscience core curriculum as presented above is 8 to 12 weeks. Ideally, this content would be delivered in an integrated course in the basic science years. However, delivery will vary with each school's curriculum and resources, and there are significant potential benefits to integrating basic science material into the clinical years.

Basic and clinical neural science material is presented in a vast variety of ways in medical schools. This variation is due to historical and philosophical development of the local curriculum and reliance on local resources. We reviewed multiple programs with an integrated neuroscience program; at many programs, 8 to 12 weeks were devoted to teaching neural science.

### **Methods of Evaluation of the Learner**

- A. Examinations (written, laboratory practicals, oral)
- B. Performance evaluations by teachers

### **Methods of Evaluation of the Teaching Process**

- A. Student performance on examinations. Such testing may include performance on standardized tests such as the USLME Step 1 and Step 2 and the National Board of Medical Examiners (NBME) Neurology Subject Examination as well as well-constructed home institution tests.
- B. Student evaluations for the teachers.
- C. Student evaluations of the course.

### **Discussion**

Preparing recommendations for a basic neuroscience core curriculum is a process that can be approached with many different philosophies. Our working group favored a more inclusive rather than exclusive process. Some who reviewed this curriculum felt that it was too extensive and contained material that is best left until the clerkship years. Others wished to further expand the topics and detail of the curriculum. Disciplines other than neural science have taken varying approaches to the problem of how much detail to put in curricular recommendations (see the Association of Professors of Gynecology and Obstetrics document as example of very detailed recommendations). We recognize that this curriculum may be implemented in various formulations because of the competing demands of multiple areas of information upon a limited medical school experience, heterogeneity of resources, structure, and mission in the curricula of medical schools. However, we believe there is value in offering guidelines.

Recommendations regarding content and methods for the basic science component of the neural science curriculum should be accompanied by suggestions for evaluation of success in meeting its goals and objectives. Obvious outcome measures might include:

- Performance of students on neural science-related questions in all steps of the USMLE
- Assessments by clerkship faculty of the degree to which students are prepared in terms of knowledge, skills, and attitudes when they come to the clinical neuroscience clerkships
- Assessments of student satisfaction with preparation as assessed by clerkship or postgraduate questionnaires

Our recommendations are not meant to serve strictly as an outline for an interdisciplinary neuroscience course but also as a guideline for consideration of basic neural science topics for inclusion in a curriculum. Some schools are responding to a call to integrate teaching of basic science throughout the entire medical school curriculum, including the clinical years (Whitcomb, 2006), and some of this material could be appropriately introduced at such times. This curricular outline serves as a first step. Broader review and the rapid pace of medical discovery will dictate the need for revision.

### **References**

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