

SERRANO: NEUROBIOLOGY 490 SPRING 2004

STUDY GUIDE FOR EXAM 1

A NOTE ABOUT THE STUDY GUIDE: Be aware that although the study guide helps review concepts, it is not all inclusive and other items emphasized in class and the readings and NOT in the study guide may appear on the exam. The study guide is therefore a good place to BEGIN exam preparation.

General approach

- Review the study guide and **Chapters 1-7**. Lots of info is presented here!
- Additional readings in the Bio office about cells and electrophysiology will be covered on the exam if they were the basis for lecture topics.
- Study your notes and all the relevant chapters. Know the meaning of all words in the boxes, and italicized. There will be some DEFINITIONS on this first exam
- Review all the images of brain anatomy in Chapter 7 and be able to label structures by filling in the blank. 20 - 30 points of exam 1 (150 points) will be taken directly from the textbook pictures of brain anatomy in chapter 7 at the end of the chapter. You will fill in the labels.
- Think about what you have learned, talk about it in a study group.

A. CELLS: GLIA AND NEURONS

This material on neuronal and glial cell biology, while only a few chapters in the required textbook, is rich in concepts and detail. Be sure you understand clearly what has been covered, as all your knowledge will build on these fundamental concepts (or unfortunately, misconceptions!).

- How are neurons classified? What are the major classification schemes for neurons?
- Be able to describe **in detail** the anatomical specializations that distinguish neurons from other cells.
- In what ways are neurons similar to one another? How are neurons different?
- What are some unique lipids and proteins found in neurons?
- How does the extracellular matrix communicate with the neuronal cytoskeleton? Hint: draw a membrane and add some transmembrane proteins. Which ones will you need to add?
- How do the structural and functional properties of dendrites and axons differ?
- What are the different types of glia? What are the roles of glia in the brain (CNS)? In the PNS? What important role do glia serve during neurogenesis?
- Briefly describe the pathway for protein synthesis of transmembrane proteins such as ion channels beginning with transcription in the nucleus and ending with a cell membrane.
- What types of metabolic modifications regulate protein activity? What are the generic names of the enzymes that accomplish this.
- What two ions mentioned in class repeatedly are tightly regulated by neurons (and all cells?). Why?
- What cytoskeletal dysfunctions are believed to underlie Alzheimer's?
- Who were Ramon y Cajal and Sherrington and what did they contribute to modern neuroscience?

B. PASSIVE AND ACTIVE ELECTRICAL PROPERTIES OF NEURONS

- What are the three laws of thermodynamics?
- What is the Maxwell Boltzmann distribution? What does this equation describe in probabilistic terms?
- What does the Nernst equation allow you to calculate? What happens at the Nernst equilibrium potential? (ie what forces are equal and opposing?). What equation is a more complex form of this equation?
- What are the properties of resistors and capacitors? How is the membrane like a parallel RC circuit? What is the time constant? what parameters will influence its value?
- How can a Nernst potential be represented by a battery and resistor? What causes ions to flow across membranes? What is the reversal potential for an ion?
- What is the relation between the Na/K ATPase and the Nernst potentials for Na and K in neurons like the squid giant axon? What is the role of the Na/K-ATPase in maintenance of membrane rest potential? In the action potential?
- What are some of the different kinds of firing patterns that are found in neurons? What is meant by stimulus/frequency response curves? What is the interspike interval? spike latency?
- Understand how the Hodgkin Huxley voltage clamp experiments were conducted. Be able to answer the following:
 - how does the Na channel/conductance respond to depolarization? the K channel/conductance?
 - contrast the V and t dependence of the Na and K channels/conductances.
 - what is the shape of the ion currents for each of these under voltage clamp?
 - how would you take a voltage clamp record of ion current vs. time and convert it to a conductance vs. time trace?
- What is the ionic basis of the action potential? explain the shape, threshold, peak, refractory period, and afterhyperpolarization in terms of voltage and time dependent conductances
- What is the length constant? What axonal properties can influence the length constant? what equation(s) describe the length constant? What factors affect action potential conduction velocity? How fast do action potentials travel?
- Explain saltatory conduction. Discuss the importance of the length constant, time constant, myelination and ion channel distribution in this phenomenon. what is the velocity of most action potentials?
- What is the patch clamp method and what are some of the advantages of using this method? What is meant by unitary channel conductance? What equation relates single channel conductance to single channel current? How can macroscopic currents be explained by single channel conductance measurements?
- What are some of the different kinds of ion channels? What is their structure? What are similarities and differences between ion channels in their structure? How can ion channels be distinguished from one another?

C. BRAIN ANATOMY

- What are major brain divisions? How do these develop from the neural tube?
- What are the cranial nerves and what info do they carry?
- What is the blood brain barrier? What are its components? Why is it needed? How do molecules cross the blood brain barrier?
- Where is the cerebrospinal fluid synthesized?