**Study Guide for Bio101 Lecture Final Exam**

**NERVOUS SYSTEM STUDY GUIDE (New Material)**

**Please note that this study guide is a listing of objectives that you are required to master for this course.  However, items mentioned in class or in laboratory as being ‘important for you to know’ may also appear on the exams.  \*\*This is NOT a legal contract - it is a STUDY GUIDE designed to help you focus your study efforts.**

**The Final Exam will be 50% cumulative (lectures 1 - 17) and 50% Nervous System (lectures 18 - 22).  The exam will have 100 questions and be multiple choice, matching, diagram, and true/false questions.  There will be a few bonus questions taken from the last part of the course (Nervous system/special senses).**

**THERE IS A LOT OF MATERIAL TO KNOW FOR THE FINAL!!!! DON’T GET BEHIND, AND MOST OF ALL DON’T GIVE UP YET – YOU ONLY HAVE A FEW WEEKS TO GO!  HANG IN THERE AND WORK HARD THESE LAST FEW WEEKS SO YOU CAN ENJOY YOUR VACATION.  **

**RESOURCES YOU MAY WANT TO USE TO AID YOUR UNDERSTANDING:**

**1. Study aids and quizzes on the** [**Mastering A&P Web site**](http://masteringaandp.com)**.**

**2. 'Links to Explore' (if any) in the Supporting Materials column of the Lecture materials for each lecture.**

**3. Interactive Physiology CD - Nervous System I and II (available in the SEC)**

**\*\*Information in square brackets [ ] is optional material and will not be tested on the main body of the exams, but may be asked in the bonus questions.**

Note that this study guide will appear to be LONG. I tried to be as specific as possible with the items I want you to know and that made the study guide longer. Dont' be intimidated by the length, or the detail. It's just a little more specific than other study guides, and I repeated some things for emphasis, because I know there is a lot of material for you to know and understand.

**Lecture 18 - Fundamentals of Nervous System (Chapter 11)**

1. State the major function of the nervous system and describe the ways in which it accomplishes this function.

2. Divisions of the nervous system

a. List the TWO major subdivisions of the nervous system.  Where is each subdivision located?

b. Explain the difference between the sensory and motor divisions.  To which major subdivision of the nervous system (that you listed in a above) does each belong?

c. Explain the difference between the somatic and autonomic divisions of the nervous system. To which major subdivision of the nervous system (that you listed in a above) does each belong?

3. Neuron structure and  function

a. Describe/draw a typical neuron and label its major structures.

b. Explain the major function of each of the following: dendrites, soma (cell body), axon, and synaptic knobs.

c. State the part of a neuron on which myelin is found.

d. List the major function of neurons.

4. Classification of neurons

a. Describe the *structural* classification of neurons.  State the major structural characteristic that is used to place a particular neuron in a given structural class.

b. Explain the *functional* classification of neurons, i.e., the role of sensory, motor, and interneurons.   List the other names for sensory and motor nerve fibers.

5. Neuroglia   (Use the *summary* ***table*** of neuroglia from lecture slides.  This is what you have to know.)

a. List/identify the general function of each of the types of neuroglia.

b. Sate where each type of neuroglia is found (CNS or PNS).

6. Membrane channels (try generating a table for this - it will make it easier to study)

a. What are the two major types of channels in a neuron that allow the flow of  ions across the neuron cell membrane?

b. For those channels that are not always open, how is each kind of channel activated (opened)?

7. Resting (transmembrane) potential of neurons

a. Explain what is meant by a transmembrane potential.

b. Explain the major physiological mechanism that establishes the resting (transmembrane) potential of neurons.  (Which ion is responsible for this, and which way does it flow?)

c. State the type of channel that is most important in establishing resting potential.

d. Describe the predominant location (intra- or extracellular) of  Na+ and K+ when a neuron is at its resting membrane potential  Do most cells in the body have the same distribution of Na+ and K+?

e. State the contribution that Na-K-ATPase pumps make to the resting membrane potential.

d. Explain why a neuron  is said to be 'polarized' when it is at its resting membrane potential.

**Note**: Some of the items below will seem redundant (unnecessarily repeated).  This is intentional so that you look at these things from more than one point of view.  It will help you understand them, so bear with me.

8. Define inhibition and excitation as related to hyper- or depolarization of the postsynaptic cell membrane.

9. Changes in membrane potential (you should refer to the Threshold and Action Potential slide for an overall view of these events)

    a. Depolarization

i. Define depolarization.

ii. Describe the ion fluxes, i.e., specific kinds of ions and their direction of movement, that cause depolarization.  (A flux, as it is used here, means the movement of ions from one place to another across a cell membrane.)

iii. State whether depolarization is excitatory or inhibitory for the postsynaptic cell?  (Phrasing it another way, when depolarization occurs would a neuron be more or less likely to send a nerve impulse to the next neuron in the chain?) Which cell is undergoing the excitation or inhibition from a depolarization, the pre- or postsynaptic cell?

 b. Repolarization

i. Define repolarization.  When does repolarization occur?

ii. What ion fluxes, i.e., specific kinds of ions and their direction of movement, cause repolarization

    c. Hyperpolarization

i.    Define hyperpolarization.

ii. What ion fluxes, i.e., specific kinds of ions and their direction of movement, would cause hyperpolarization.

iii. State whether hyperpolarization is excitatory or inhibitory for the postsynaptic cell?  (Phrasing it another way, when hyperpolarization occurs would a neuron be more or less likely to send a nerve impulse to the next neuron in the chain?) Which cell is undergoing the excitation or inhibition from a hyperpolarization, the pre- or postsynaptic cell?

10. Action potentials

a. Define the terms *threshold* and *action potential*.

b. State the location in the neuron where an action potential begins.  Why does it begin here? (relate the structure to the function to answer this)

c. Describe the changes in membrane potential that occur in a neuron during an action potential (nerve impulse) and the define terms used to describe those changes, i.e.,  depolarization, repolarization, and hyperpolarization.  It might be a good idea to draw this as a diagram; you should refer to the Threshold and Action Potential slide for an overall view of these events.)

d. Define the Absolute Refractory Period (ARP) and the Relative Refractory Period (RRP).

e. Why is the Absolute Refractory Period important to the transmission of a nerve impulse in the proper direction down an axon?

11. Graded potentials

a. Define a graded potential.

b. Explain the difference between a graded potential and an action potential.

c. State the types of membrane channels are involved in graded potentials. Where are these channels located on the neuron: dendrites, soma, or axon?

d. Describe how a graded potential can eventually cause an action potential to occur.

e. Explain why not every graded potential causes an action potential to occur.

12. Myelination

    a. Describe the myelin sheath found around certain nerve fibers and explain its importance.

    b. List/identify the cells that produce myelin in the PNS and CNS.  What is the general name given to these types of cells?

    c. What term is used to describe nerve impulse transmission (propagation) in myelinated fibers?

14.  Explain/diagram the steps involved in nerve impulse transmission across chemical synapses. Try and draw this as a diagram, labeling the items in your drawing. (See the slide, Chemical Synaptic Synapse.)

15. Excitatory (EPSP) and Inhibitory (IPSP) Post Synaptic Potentials

    a. Explain the effect of EPSP's and IPSP's on the postsynaptic neuron.

    b. How are EPSPs and IPSPs related to de- and hyperpolarization?

    c. Which ions could cause each of these?  Which way would the ions you listed have to flow (into or out of the postsynaptic neuron)?

16. Define spatial and temporal summation.  To what type of potentials (graded or action) do these terms apply?

17. What is the role of acetylcholine and norepinephrine in the CNS and PNS, and the role of GABA in the CNS?

18. **This is an INTEGRATION item designed to pull together some of the isolated facts you have accumulated above so THINK about the answers and spend some time with this.  Figuring out these answers, and looking at them as a whole, will help you understand all of the other facts you have gathered above and why they're important.  Get a study buddy or two and work on this section together after you've completed items 1 through 17 yourself.  Brainstorm!**

- What is the name given to the chemicals that bind to ligand gated channels in the nervous system?  Give two examples of these.

- To what type of membrane channel protein (receptor) do these chemicals bind?

- When these chemicals bind to their receptors, what type of potential (graded or action) do they create in the postsynaptic cell?  How do temporal and spatial summation apply here?

- How can these chemicals cause, or prevent, and action potential from being generated in the postsynaptic neuron?

- Describe what happens if an action potential is generated, taking into account the following: What kind of channels open and close? What happens to the membrane potential and polarization during an action potential? What ions flow in/out of the neuron and when;  How does the action potential travel along the axon in a myelinated or an unmyelinated neuron?  What makes an action potential travel in the 'right' direction).

- If an action potential is generated, how is this 'message' passed along to the next neuron in a nerve pathway?

- What structures in the postsynaptic neuron determine the effect of an action potential, i.e., whether it is excitatory or inhibitory?

 **Lecture 19 – The Central Nervous System (Chapter 12)**

(Be sure to have the summary tables of the parts of the brain in your textbook handy for this part of the Study Guide.  Use those tables, or even better - make your own!)

1. What are the ways in which the brain is physically and chemically protected?

2. Meninges (sing: meninx)

    a. Identify/name and locate each of the meninges and the meningeal spaces in the brain and spinal cord.

    b. Define the blood-brain barrier and state its importance.

3. Cerebrospinal fluid (CSF)

    a. Explain the function of the choroid plexus and role of the ependymal cells in the generation of CSF.

    b. What general type of cell is an ependymal cell?

    c. After being made, where does the CSF go, i.e., how does it circulate throughout the CNS?

    d. In what meningeal space does CSF circulate?

4. Cerebrum

    a. Which lobes of the cerebrum are considered mainly motor? Sensory? Association?

    b. Where is the primary motor cortex?  What is another name for it?  What type of nerve impulses begin there? With what other lobe(s) does the primary motor cortex communicate?

    c. Where is the primary sensory cortex?  What is another name for it?  What type of nerve arrive there?  With what other lobe(s) does the primary sensory cortex communicate?

    d. With which specific *layer* of the cerebrum are the motor and sensory homunculi associated?

    e. List the major functions of each of the cerebral lobes (see Table 11.5 in Hole) as highlighted in your lecture slides.

    f. Identify the usual location and explain the importance of Broca’s and Wernicke’s areas.

5. Basal nuclei

    a. What are names of the basal nuclei?

    b. What is the major function of the basal nuclei?

    c. What is a 'nucleus' in the CNS, anyway?  How is it different from a 'ganglion'?

6. 'Lower' brain

    a. List the general characteristics and general functions (as highlighted on your lecture slides; also see Table 11.7 in Hole) of the

        i. Thalamus

        ii. Hypothalamus

        iii. Three parts of the brainstem (midbrain, pons, medulla oblongata).

    b. Explain the importance and function(s) of the reticular formation (Reticular Activating System) as highlighted on your lecture slides.

    c. What are the major functions of the limbic system?

7. Memory

    a. Define a 'memory'.

    b. Explain the difference between immediate, short-term, and long-term memory.  You should know an example of each.

8. Spinal cord

    a. What are the major functions of the spinal cord?

    b. Where is the cauda equina located?

    c. Where in the spinal cord are the cell bodies of somatic *motor* neurons located?   Where are the cell bodies of somatic *sensory* neurons located?

    d. Explain the naming convention used to describe ascending or descending spinal nerve tracts and state the type of information each type of tract carries.

    e. Spinal tracts

        i. What is a 'tract' in the spinal cord?

        ii. Do tracts contain neuron cell bodies or axons of neurons?

        iii. Given the name of a spinal nerve tract, identify the general type of information it carries (motor or sensory) and the direction of information flow (ascending, descending).

    f. Where are 1st, 2nd, and 3rd order neurons found?  Are they part of sensory or motor pathways?  Where do 1st & 2nd, and the 2nd & 3rd order neurons synapse with each other?

    g. Where are lower and upper motor neurons found?  Where do lower and upper motor neurons synapse?

9. Reflexes

    a. What is the definition of a reflex?

    b. Do reflexes occur in the somatic division of the nervous system, the autonomic division, or both?

    c. Describe the general, typical spinal reflex mechanisms (reflex arc, knee-jerk reflex, withdrawal reflex, crossed-extensor reflex) and identify the number of synapses in each type of reflex arc.

  **Lecture 20 – Peripheral Nervous System and Reflexes (Chapter 13)**

1. From where do cranial nerves arise?  For each of the cranial nerves, identify the name, number, and major function (as listed on the table in your lecture slides) and whether it is sensory, motor, or mixed (both) [Table 11.9 Hole / Lecture mnemonics & table]

**Tip to help you recall the table**: Write numbers 1 through 12 and then use the mnemonic to list the name of each cranial alongside the number (so you will go in ascending numerical order, which is the way the 'Old Opie...' phrase goes).  Use the 'type of nerve' (Big boobs) mnemonic to list whether a CN is sensory, motor, or both.  \*\*\*You might want to jot the table down on a blank page as soon as you get your exam so you have it right in front of you when you need to answer questions about the CNs.  That way, worrying about having to recall the table won't distract you while you try to answer other questions.

As far as the functions of the CNs, we will talk more about the Olfactory, Optic, Oculomotor, Trochlear, Abducens, and Vestibulocochlear CNs in lab and again when we do the lectures on Special Senses.  That will help you learn and remember their functions.

To remember the functions of the remainder of the CNs (Trigeminal, Facial, Glossopharyngeal, Vagus, Accessory, and Hypoglossal) you can use word associations to help you.

Of course, the BEST phrases and mnemonics are the ones YOU come up with yourself.  But as an example, to remember that the Trigeminal CN is the major sensory nerve of the face, you might use the phrase, "FACE the facts, THREE GEMS cost a lot of CENTS (SENSE)".  This is a G-rated mnemonic.   Make YOUR mnemonics X-rated so you remember them!  Make the pictures in your mind very SILLY, very VIVID, very SEXY, very DISGUSTING, very COLORFUL, and ACTION PACKED.  The more crazy, colorful and active your pictures, the better you will remember them.   Just don't get TOO 'distracted' while you're doing this!!  :-) Have fun with this stuff - and you'll remember it!!

2. Peripheral nerves

    a. Define the terms general/special, afferent/efferent, somatic/visceral as they apply to classification of nerves.

 b. What types of structures do SOMAtic nerves innvervate?

    c. Describe the general structure, in order, of peripheral nerves (epineurium, perineurium, endoneurium) proceeding from the gross level to the microscopic level or vice versa.  (Just like the layers of CT in muscle!)

    d. Explain the difference between a peripheral nerve and a nerve fiber.

3. Spinal nerves

    a. What is meant by a spinal nerve?  What kinds of nerve fibers (sensory, motor, or both) do spinal nerves contain?

    b. Explain the method of naming spinal nerves and identify how many spinal nerves there are.

    c. For each of the cervical, brachial, and lumbosacral nerve plexuses, describe the level of spinal cord at which each originates, and the major nerves and structures supplied by them. (See the summary table in your Study Notes for the Nervous System)

4. Be able to locate the following: ventral root, dorsal root, and dorsal root ganglion.  What is contained in the ventral root?  Dorsal root?  Dorsal root ganglion?

**Lecture 21 – Autonomic  Nervous System (ANS) - (Chapter 14)**

\*\*Be sure to look at the summary table for the ANS in these review slides This contains most of what you need to know.

1. Identify the major divisions of the ANS and explain the general function of each.

2. Define the terms preganglionic, postganglionic, paravertebral ganglia, prevertebral ganglia, and sympathetic trunk.

3. Describe the GENERAL anatomical structure of the sympathetic and parasympathetic nerve pathways paying attention to the following:

    a. The length of the preganglionic and postganglionic fibers

    b. Areas of the CNS from which each branch of the ANS arises

    c. Types/names of ganglia found in each branch

    d. Examples of organs innervated by each

4. Describe the general conditions (including the 'E' situations) that activate the sympathetic nervous system and what happens to major organs after this system is activated.

5. Contrast the innervation of the adrenal gland by the sympathetic nervous system with other organs innervated by sympathetic nerves, i.e., what's different about it?

6. Describe the general conditions that activate the parasympathetic nervous system and what happens to in the body after this system is activated (memory aid: SLUDD and the 3 Decreases).

7. What types of fibers do autonomic plexuses contain? Name the major autonomic plexuses.

8. Describe the neurotransmitters used by the ANS (pre- and postganglionic) and the types of receptors (adrenergic, cholinergic) used by each type of ANS nerve fiber.

9. If the sympathetic and parasympathetic ganglia were flooded with ACh, would this a decrease or increase the amount of NE released by sympathetic postganglionic neurons?  Why?

**Lecture 22 - Special Senses (Chapter 12)**

1. List the five general groups of sensory receptors and explain the function of each.

2. Explain the function of the two types of mechanoreceptors.  What kind of membrane channel proteins would mechanoreceptors have?  How would they be opened (activated)?

3. List the two types of proprioceptors in skeletal muscle, state when each type of proprioceptor is activated, and describe its effect on muscles after being activated.

4. Define sensory adaptation and explain the consequences and usefulness of adaptation.

5. List the three types of receptors for touch.

6. Explain what happens when a stimulus exceeds the capability (too hot or too cold) of a thermoreceptor.

7. What is another name for a pain receptor?   With regard to sensory adaptation, what is different about pain receptors ?

Continued next page...

8. For the ear:

            a. Describe the mechanism, importance, and limitation of the tympanic reflex.

            b. Explain the importance/function of the auditory (Eustachian) tube and circumstances that may interfere with its proper operation.

c. Describe the steps in the generation of sensory impulses from the ear (Figure 15.30 in Marieb).

d. Describe the location and function of the organ of Corti, the semicircular canals and their ampullae, and the utricle and saccule and their maculae.

e. Define static and dynamic equilibrium, and which organs of the inner ear carry out each type of equilibrium.

9. For the eye:

a. Describe the structure of the eyelids, the names of their major glands, and the general actions of the muscles that control them.

            b. Describe/label the lacrimal apparatus and explain the function of tears.

c. List the actions of the six (extrinsic) extraocular muscles and state which cranial nerve innervates each muscle.

d. Describe the structure and function of the lens of the eye.

e. Where is the aqueous humor of the eye located?  Where in the eye is it made?  Where is the vitreous humor of the eye located?

f. Explain the function of the scleral venous sinuses (canals of Schlemm) and describe what happens if these venous sinuses are blocked.

             g. Accommodation

                i. Explain the importance of accommodation.

                ii. How does accommodation take place?

 iii. What happens to the lens of the eye during accommodation, and what muscles are involved.

 iv. As someone gets older and their lens gets stiffer, how would this affect accommodation?

h. Describe the anatomic arrangement of the two sets of smooth muscles in the iris. Which branch of the ANS controls each.  Why is such control important?

            i. Compare and contrast the location and function of the rods and cones.

            j. Define the terms optic disk, macula lutea, and fovea centralis.  Which area of the retina will produce the best vision when light strikes it?  Which area of the retina will not generate any nerve impulses when light strikes it?

            k. Which hemisphere of the brain receives visual information from the *medial* portion of the retina of the eye?  Which hemisphere of the brain receives visual information from the *lateral* portion of the retina of the eye?