

MIDTERM EXAM 1  
COGNITIVE SCIENCE 107A  
FALL 2011

Points: \_\_\_\_\_ / 100

Name: \_\_\_\_\_

PID: \_\_\_\_\_

**I. SHORT ANSWERS** (6 points each for a total of 30 points)

1. Describe two contributions made by Ramon y Cajal (1852-1934) in terms of understanding how the brain works.

He proposed the Neuron Doctrine, which states that neurons are independent units and that there are gaps between cells through which they communicate via neurotransmitters.

He also proposed the Law of Dynamic Polarization which views the dendrites as the input area, the cell body as that which integrates the input, and the axon as the area carrying the output signal to other neurons.

2. Describe three properties of the brain that define it as a self-organizing system.

A. The absence of centralized control and the presence of competition among many of the parts that make up the brain.

B. An insensitivity to damage or a high degree of redundancy

C. Capacity for self repair or maintenance

3. During the differentiation phase of brain development, axons must find their way to their targets. Briefly describe three strategies for long-distance targeting.

A. Chemotropism: diffusible chemical gradients that attract or repel the neuron

B. Guide post cells or distributed positional cues: cells or cues that are strategically located in various areas of the developing brain to guide the neuron in a stepwise fashion

C. Preformed pathways or labeled lines: These are formed by things like the radial glial cells or pioneer neurons, which form neural scaffolding that helps guide cells to their destination

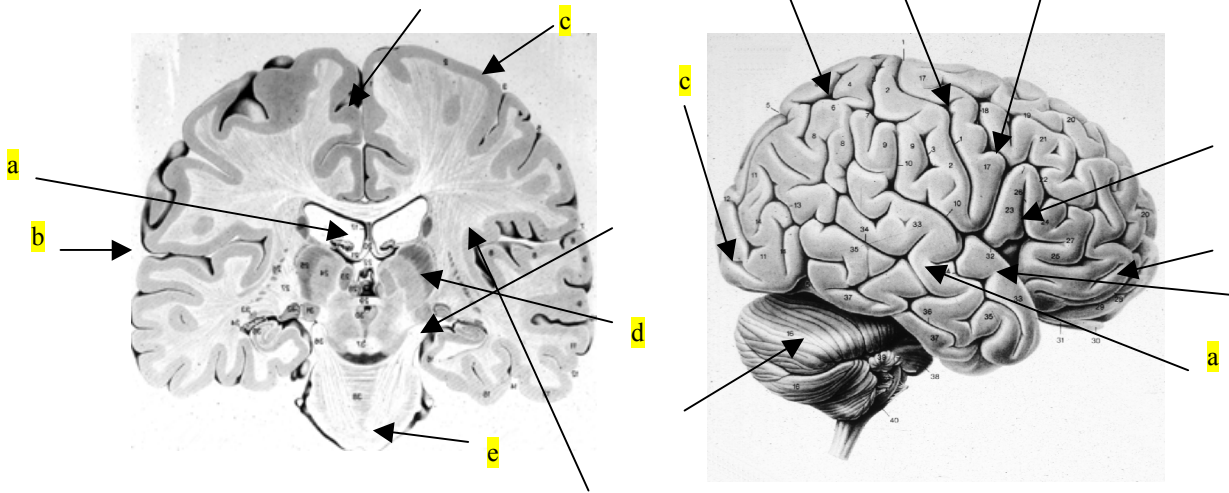
4. Describe the Hebbian learning rule that may be the basis for the 'withdrawal' of synaptic connections.

Synaptic efficacy decreases if there is uncorrelated activity in the pre- and post-synapse

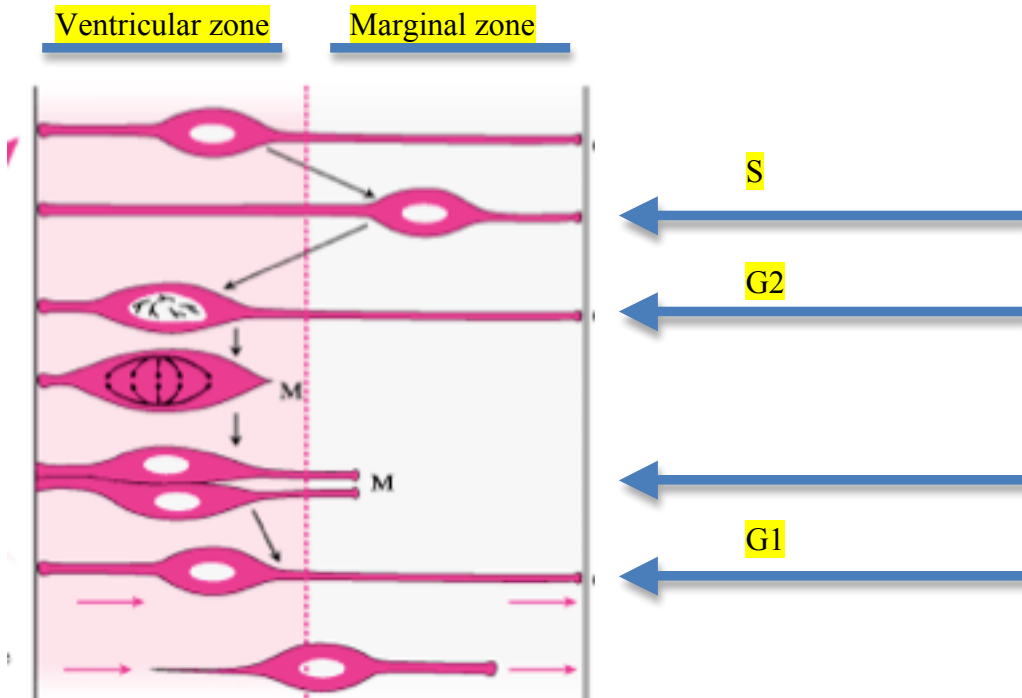
5. Describe the roles that mitochondrial damage and inhibitory apoptosis proteins play in programmed cell death.

Damage to the mitochondria produces the release of a substance called Diablo (or Smac) which removes the inhibition that the inhibitors of apoptic proteins have on caspases. Removal of that inhibition essentially activates the caspases to start programmed cell death.

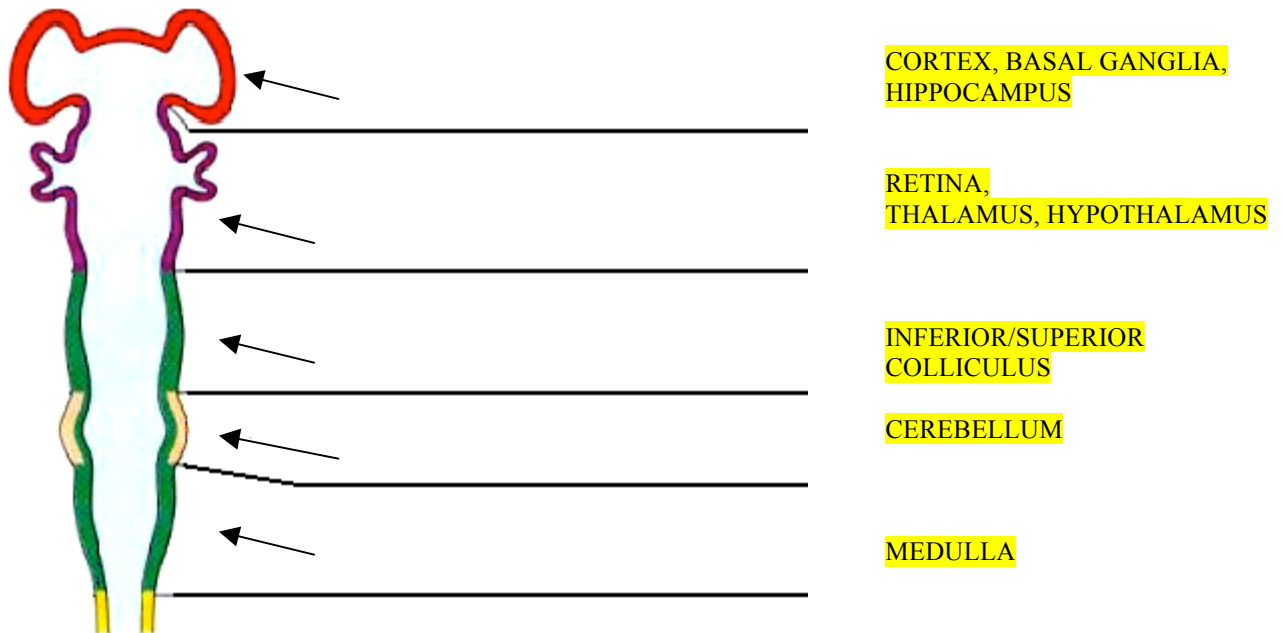
**II. DIAGRAM (total of 20 points)**



6. (5 pts) In the sagittal view above, please label each of the following areas with the appropriate letter: a) superior temporal gyrus; b) central sulcus; c) area V1; d) parietal cortex; e) inferior frontal gyrus.
7. (5 pts) In the coronal view of the brain above, please label each of the following areas with the appropriate letter: a) lateral ventricles; b) Sylvian fissure; c) cortex; d) basal ganglia; e) medulla.
8. (5 pts) In the diagram below, please match the following terms with the specific layer or phase: A. G2 phase; B. Ventricular zone; C. G1 phase; D. Marginal zone; E. S phase.



9. (5 pts) In the drawing of the neural tube below, please list a functionally specific brain area that arises from each of the specified regions (each is a distinct answer).



**III. MULTIPLE CHOICE** (One correct answer per question. A total of 10 pts)

10. Which of the following is a lesson about the brain that we have learned from studying evolution:
- The current (brain) model is the result of hundreds of years of evolution.
  - Evolution has a master plan.
  - New capabilities have been added on to existing hardware.**
  - The brain is organized and specialized in at least four dimensions.
  - Solutions to problems are optimal
11. RELN is a protein whose absence during brain development produces:
- Lack of closure of the head area of the neural tube
  - Hydroencephaly
  - Absence of exuberancy during synaptogenesis
  - Migration problems**
  - Unprogrammed cell death
12. During the differentiation phase of brain development:
- Cells acquire a phenotype**
  - Synaptogenesis begins
  - Cells in the ventricular zone migrate to the cortical plate
  - The neural plate becomes the neural groove and that becomes the neural tube
  - Cells begin to divide at a very fast rate
13. Once uninhibited, these molecules chew up cell proteins and DNA during apoptosis
- Caspases**
  - IAPs
  - Diablo proteins
  - Bcl-2
  - Microglia

14. It has been hypothesized that some primate brains became larger and smarter (through evolution) because of:
- A. Changes in body size
  - B. Stay at home strategies
  - C. Complexities in extracting food
  - D. Larger digestive system
  - E. None of the above
15. The Law of Dynamic Polarization states that:
- A. The brain is composed of cells that are structurally connected
  - B. Electrical conduction of information flows in one direction
  - C. The brain is composed of cells that are structurally disconnected
  - D. Cells are not functionally independent
  - E. Electrical conduction of information can flow in both directions
16. The meninges are composed of 3 layers arranged in the following order from outside (next to skull) to inside (next to brain):
- A. Dura, pia, arachnoid
  - B. Pia, arachnoid, dura
  - C. Arachnoid, dura, pia
  - D. Arachnoid, pia, dura
  - E. Dura, arachnoid, pia
17. The evolution of the central nervous system from Cnidaria (e.g., jellyfish) to flatworms was characterized by:
- A. Moving of the eyes to the front of the head
  - B. The ability of mammals to climb trees
  - C. The appearance of 3-layer networks
  - D. Increased segmentation and specialization
  - E. None of the above
18. Myelination does NOT:
- A. Occur in the PNS (peripheral nervous system)
  - B. Insulate the axon
  - C. Speed up conduction
  - D. Save energy
  - E. Stop postnatally (after the baby is born)
19. The reorganization of the ocular dominance columns in V1 due to loss of input from one eye is an example of:
- A. Neural Darwinism
  - B. Radial glial function
  - C. Neurogenesis
  - D. Cell differentiation
  - E. Apoptosis

**IV. FILL-IN-THE -BLANK** (1 point per answer for a total of 15 points)

20. Follistatin, noggin, and chordin inhibit BMP2/4 in specific parts of the ectoderm, ultimately influencing those areas to become neural tissue.
21. Layer 4 of cortex receives input from thalamus; Layer 1 contains primarily axons; and Layer 6 sends output to thalamus.

22. Actin molecules are found on the surface of the filopodia of the growth cone.
23. Exuberancy refers to the increase in redundant connections made by a neuron during synaptogenesis - some of which are later retracted.
24. Accumulation of CSF in the ventricles results in a condition known as hydroencephaly.
25. Sulci refers to folds in the cortex, while gyri refers to the outer surface areas that are not folded.
26. Fasciculation is the process in which CAMS (*name of molecules*) help bind growing axons together as they migrate to their target destinations.
27. The endoplasmic reticulum plays a role in protein synthesis, while the mitochondria (*organelle in the cell body*) are mainly involved in energy production.

**V. TRUE/FALSE** (1 point for each answer for a total of 10 points).

28. Cell death via apoptosis during the life of a human being is considered normal. T
29. Class 1 structures formed during migration lack laminar organization F
30. Homologous areas refer to those that have similar function but evolved independently F
31. CSF is important as a transport mechanism for migrating axons. F
32. Increased brain complexity in evolution produces increased cortical lamination of cortex. T
33. The corpus callosum are axonal fibers responsible for conducting information from one cortical hemisphere to the other T
34. Encephalization refers to the fraction of gross brain size that represents neuronal processing capacity that is not related to body size T
35. Radial glial cells are the primary guidance mechanisms early in migration. T
36. The choroid plexus is found inside ventricles and is involved in producing cerebral spinal fluid. T
37. The Neuron Doctrine states that cells in the brain are bioelectrically driven F

**VI. MATCHING** (1 point per answer for a total of 15 points).

38. Match the phases of development with the processes going on during that phase.
- |                                 |   |
|---------------------------------|---|
| <u>f</u> Migration              | a. neural plate → neural groove → neural tube |
| <u>d</u> Differentiation        | b. G1-S-G2-M                                  |
| <u>a</u> Neurulation            | c. ocular dominance columns                   |
| <u>b</u> Proliferation          | d. acquiring phenotype                        |
| <u>e</u> Synaptogenesis         | e. growth cone                                |
| <u>c</u> Synaptic rearrangement | f. radial glia                                |
39. Match the glial cell with its function
- |                          |   |
|--------------------------|---|
| <u>c</u> oligodendrocyte | a. myelination of axons in PNS                  |
| <u>e</u> astrocyte       | b. lines ventricles/ involved in CSF production |
| <u>d</u> microglia       | c. myelination of axons in CNS                  |
| <u>b</u> ependymal       | d. mediators of immune response                 |
| <u>a</u> schwann         | e. source of CAMs and growth factors            |
40. Match the type of mapping with the closest associated structure/function
- |                      |                            |
|----------------------|----------------------------|
| <u>d</u> retinotopic | a. A1 area                 |
| <u>a</u> tonotopic   | b. touch                   |
| <u>c</u> mototopic   | c. homunculus for movement |
| <u>b</u> somatotopic | d. V1 area                 |