Nsci 4100: Development of the Nervous System
2016 Examination 1

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Class 2 neuro 101
1. Which of the following is true regarding a neuron at rest?
   A. It has a higher concentration of sodium (Na+) inside the cell than outside.
   B. It has a higher concentration of chloride (Cl-) inside the cell than outside.
   C. It has a higher concentration of both Na+ and Cl- inside the cell than outside.
   → D. It has a higher concentration of potassium (K+) inside the cell than outside.
   E. None of the above are correct.

2. An action potential is initiated in the initial segment of an axon when the neuron becomes sufficiently depolarized. True or false?
   → A. true
   B. false

3. Which of the following types of synapses do NOT normally exist in the nervous system?
   A. axodendritic
   B. axosomatic
   C. axoaxonic
   D. dendrodendritic
   → E. None of the above are correct in that the all exist in the nervous system.

4. Neurotransmitter receptors are concentrated in …
   A. synaptic vesicles
   → B. postsynaptic density
   C. presynaptic density
   D. synaptic cleft
   E. More than one of the above are correct.

5. Which of the following is NOT a function of astrocytes?
   A. contribute to the blood-brain-barrier.
   → B. myelinate axons.
   C. insulate synapses.
   D. remove neurotransmitter.
   E. More than one of the above are not functions of astrocytes.

Class 3 & 4 embryology
6. Incomplete closure of the caudal end of the neural tube results in a clinical condition called ____________. (Fill in the blank.)
   A. megacephaly
   B. anencephaly
   C. microcephaly
   D. spinacephaly
   → E. spina bifida
7. The optic vesicle forms from the …
   A. metencephalon
   B. mesencephalon
   C. rhombencephalon
→ D. prosencephalon
   E. More than one of the above are correct.

8. Which of the following does NOT develop from the telencephalon?
   A. olfactory bulb
   B. basal ganglia
→ C. hypothalamus
   D. cerebral cortex
   E. More than one of the above do not develop from telencephalon.

9. Which of the following develop from basal plate?
   A. projection neurons in neocortex (i.e. neurons with long projecting axons)
→ B. motor neurons in spinal cord
   C. schwann cells in the sciatic nerve
   D. sensory neurons in a spinal ganglion
   E. More than one of the above are correct.

10. The cerebellum develops …
→ A. from the rhombic lip.
    B. from basal plate.
    C. from the mesencephalon.
    D. ventral to the sulcus limitans.
   E. More than one of the above are correct.

11. Imagine that you stably transfected a small group of cells with a constitutively expressed reporter gene such as green fluorescent protein (GFP) just off the midline in the posterior neural plate as indicated in the figure. All cells generated by division of the transfected cells would carry the GFP gene and express GFP. Which of the following cell types in the adult do you think would most likely express GFP?
   A. neurons in a brainstem sensory nucleus
→ B. motor neurons in the spinal cord
   C. neurons in dorsal horn of the spinal cord
   D. neurons in dorsal root ganglia
   E. More than one of the above are correct.

Class 5 induction
12. Which of the following is true?
→ A. Mesoderm induces ectodermal cells to become nervous system.
    B. Mesoderm induces endodermal cells to become nervous system.
    C. Ectoderm induces endodermal cells to become nervous system.
    D. Ectoderm induces mesodermal cells to become nervous system.
    E. Endoderm induces ectodermal cells to become nervous system.
Everyone received credit for the next question.

13. Incubating early amphibian animal cap in culture with a medium supplemented with an excess of which of the following proteins is likely to result in the cells developing a neural fate?
   - A. BMP4
   - B. truncated activin receptor
   →  C. follistatin
   - D. Sox2
   - E. More than one of the above are correct.

14. What effect is transplantation of a second notochord to the lateral side of the early neural tube likely to have?
   - A. No neural crest cells will develop.
   - B. More neural crest cells than normal will develop.
   →  C. More motor neurons than normal will develop.
   - D. The area of the neural tube next to the transplanted tissue will develop into mesodermal tissue.
   - E. The area of the neural tube next to the transplanted tissue will develop into epidermis.

15. Placing a blastula stage frog embryo in a high salt solution will cause it to exogastrulate. What effect will this have on subsequent development?
   - A. The embryo will develop two body axes including two neural tubes.
   - B. A single neural tube will form that will be caudalized. (i.e. mostly spinal cord will develop with little or no brain)
   →  C. A single neural tube will form that will be rostralized. (i.e. mostly brain will develop with little or no spinal cord)
   - D. The neural tube will not form.
   - E. More than one of the above are correct.

Class 6 & 7 regionalization (from Dr. Nakagawa)

16. Which of the following is true about the early regionalization of the central nervous system?
   - A. The rostral end of the neural plate becomes the thalamus.
   - B. The lateral margins of the neural plate become the ventral end of the neural tube.
   - C. The anterior-posterior axis of the neural plate becomes curved as the brain develops.
   →  D. Identity of a neuron in the brain is influenced by the position of the progenitor cell that produces the neuron.
   - E. More than one of the above are correct.

17. Which of the following statements is true about the Wnt signaling pathway in regionalization?
   - A. In vivo over-expression of Wnt3A and Noggin in Xenopus will result in expression of forebrain marker Bf1 but not the hindbrain marker Krox20 in neural tissue.
   - B. Activity of Wnt/β-catenin signaling pathway can be assessed by the expression of transgene reporting a transcriptional activation through TCF/LEF proteins.
   - C. Without binding of Wnts to the FRIZZLED/LRP receptor, β-catenin will be sequestered into the nucleus.
   - D. Wnt antagonists including Cerberus and Dkk1 are expressed in the anterior part of the gastrula of Xenopus embryos.
   →  BD E. More than one of the above are correct.
18. Which of the following statements is true about activation-transformation model of regionalization?
   A. In Nieuwkoop’s experiments in the 50’s, the level of the graft in the host always determined the regional character of the most rostral neural tissue in the graft.
   B. Activation occurs via inhibition of Wnt signaling.
   C. Caudalization activity typically comes from the axial mesoderm.
   D. Retinoic acid is an example of the caudalization activity.
   E. More than one of the above are correct.

19. Which of the following statements is NOT true about the anterior-posterior patterning of Drosophila embryos?
   A. mRNAs for bicoid and nanos start to be detected after fertilization.
   B. Diffusion of the Bicoid protein results in the formation of a concentration gradient, which regulates the expression of gap genes such as Hunchback.
   C. Pair-rule genes are required for alternative body segments.
   D. Segment polarity genes Wingless and Hedgehog enhance each other’s expression in neighboring cells.
   E. More than one of the above are not true.

20. Which of the following statements is true about homeobox genes?
   A. Homeobox genes encode proteins that include a conserved DNA binding domain called the homeodomain.
   B. Within the central nervous system, homeobox genes are expressed specifically in the hindbrain and spinal cord.
   C. Clineality means that the order of Hox genes on the chromosome corresponds to the order in which they are expressed along the anterior-posterior axis of the body.
   D. An extra pair of wings in the Ultrabithorax mutation in Drosophila is caused by the transformation of one thoracic segment to another thoracic segment.
   E. More than one of the above are correct.

21. Which of the following statement is NOT true about secondary organizers?
   A. They are formed within the developing neural tissue.
   B. Their formation requires signals from outside of the neural tissue.
   C. Response of neural progenitor cells to signals from secondary organizers is not influenced by the location of these progenitor cells.
   D. The initial, coarse anterior-posterior patterning of the neural plate results in the formation of the isthmic organizer at the junction between the expression domains of two transcription factors.
   E. More than one of the above are not true.

22. Which of the following statement is NOT true about retinoic acid (RA) in regionalization?
   A. RA binds to specific receptors that bind to DNA and activate transcription.
   B. RA is produced from vitamin A, which needs to be taken from outside of the body. If you feed a female mouse with vitamin A deficient diet during early gestation period, the embryos will have expanded posterior hindbrain at the expense of the anterior hindbrain.
   C. Many Hox genes are directly regulated by the RA receptor.
   D. All of the above are true.
   E. More than one of the above are not true.
23. Cell division in the early neural tube is described as mostly …
   A. symmetric
   B. asymmetric
   C. linear
   D. basal
   E. apical

24. Which of the following is NOT true regarding neuroepithelial cell in the early neural tube?
   A. During cell division the cell that does not inherit the newly synthesized centrosome will typically divide again.
   B. A neuroepithelial cell typically has a process extending through the entire thickness of the neural tube when it enters M-phase.
   C. A neuroepithelial cell typically has its nucleus at the apical side of the cell when it enters M-phase.
   D. Adherens junctions adhere most neuroepithelial cells to the pial surface.
   E. More than one of the above are not true.

25. In the early neural tube, a basal lamina is present …
   A. on the ventricular surface of the tube.
   B. on the pial surface of the tube.
   C. between neuroepithelial cells in the ventral neural tube.
   D. between neuroepithelial cells in the dorsal neural tube.
   E. More than one of the above are correct.

26. What type of progenitor cell is present in the developing cortex of primates that is particularly rare in lower mammals and is believed to be responsible for the large size of primate cortex?
   A. radial glia
   B. subventricular zone cells (intermediate progenitor cells)
   C. outer subventricular zone cells (outer radial glia)
   D. inner radial glia
   E. transit amplifying cells

27. As development progresses, the length of the cell cycle increases in the neural tube. This is largely due to an increase in the length of what phase of the cell cycle?
   A. G1
   B. G2
   C. S
   D. M
   E. More than one of the above are correct.

28. In humans, all neurogenesis is complete by puberty, although glia continue to be born. True or false?
   A. true
   B. false
29. In progenitor cells at the end of M-phase in developing mammalian brain, what protein required for progression of the cell cycle is expressed at very low levels?
   A. retinoblastoma protein
   B. cyclin dependent kinase 4/6
   C. cyclin D
   D. p27/Kip1
   E. More than one of the above are correct.

30. When a growth factor such as EGF acts on neuroprogenitor cells via its signaling cascade it typically results in increased expression of what protein?
   A. retinoblastoma protein
   B. cyclin dependent kinase inhibitor
   C. E2F transcription factors
   D. cyclin D
   E. More than one of the above are correct.

31. Basal plate is induced in the developing spinal cord by high concentrations of what factor?
   A. FGF
   B. Wnt
   C. BMP
   D. Shh
   E. More than one of the above are correct.

32. Most retinal ganglion cells are born in central mouse retina from embryonic day 11 (E11) through E14. Other retinal cell types are generated after ganglion cells. If you administered a drug on E12 that selectively killed all retinal ganglion cells postmitotic on that day, what effect would you most likely see over the next several days of development? (Assume the drug is cleared from the system in less than a day.)
   A. Development of cell types other than ganglion cells would be delayed.
   B. Development of cell types other than ganglion cells would be accelerated.
   C. Development of more ganglion cells would cease on E12.
   D. Development of ganglion cells would continue longer than E14.
   E. More than one of the above are correct.

33. A proneural protein such as neurogenin (Neurog1) functions by …
   A. activating a cascade of kinases.
   B. forming a dimer, typically with an E-protein.
   C. binding the E-box in the regulatory region of genes.
   D. activating its receptor on the cell surface.
   E. More than one of the above are correct.

34. Activation of Notch in a progenitor typically …
   A. inhibits differentiation.
   B. promotes differentiation.
   C. drives a change in the potential cell fate.
   D. initiates cell death.
   E. More than one of the above are correct.
35. Treating migrating neural crest cells with Neuregulin-1 and BMP2 is likely to induce them to differentiate as what cell type?
   - A. satellite glial cells
   - B. sensory ganglion neurons
   - C. autonomic ganglion neurons
   - D. melanocytes

36. The final fate of a cell in the nervous system is determined during its final division and cannot be altered by environmental influences after its terminal division. True or false?
   - A. true
   - B. false

37. β-catenin functions in the nucleus to promote expression of its target genes in response to what extracellular factor?
   - A. FGF
   - B. Wnt
   - C. BMP
   - D. Shh
   - E. retinoic acid

**Class 13 discussion**
38. In the early developing vertebrate spinal cord, what secreted factor promotes expression of cyclin D?
   - A. Wnt
   - B. Shh
   - C. Notch
   - D. EGF
   - ABD E. More than one of the above are correct.

**Class 14 research (from Dr. Lanier)**
Everyone received credit for the next question.
39. Which of the following statements about medium spiny neuron (MSN) development is true?
   - A. MSNs are born in the medial ganglionic eminence.
   - B. Dopamine reduces MSN dendritic arborization by activating a D1/D2 receptor heterodimer.
   - C. FoxP1 expression is required for migration of MSN progenitors.
   - D. More than one of the above are correct.
   - E. None of the above are correct.

**Class 15 research (from Dr. Nakagawa)**
40. Which of the following statement is NOT true about development of the thalamus?
   - A. The embryonic thalamus is composed of two distinct progenitor domains, and their identities are controlled by Sonic hedgehog.
   - B. All thalamic neurons are generated directly from radial glial cells.
   - C. Nuclear identity of thalamic progenitor cells is already specified in radial glial cells.
   - D. The thalamus is composed exclusively of excitatory neurons.
   - E. More than one of the above are not true.

*The End!*
Please turn in this exam and your bubble sheet in the box at the back of the room. Double check that your name is on both.