Name _____KEY_____

Nsci 4100: Development of the Nervous System
2017 Examination 1

Write your name on this page! On your scantron answer sheet, enter your name (last name, space, first name), internet ID (X.500 name) and student number. Please do it now!!!

Class 2 neuro 101

1. Which of the following cell types would not normally be found in the spinal cord?
   - A. oligodendrocyte
   - → B. schwann cell
   - C. astrocyte
   - D. microglia
   - E. More than one of the above are correct.

2. Which of the following statements regarding neurons in NOT true?
   - → A. Some types of neurons have multiple axons emanating from their somas.
   - B. Some types of neurons do not have an axon.
   - C. Some types of neurons do not have a dendrite
   - D. Every neuron has a soma.
   - E. More than one of the above is NOT true.

3. Early histologists described the soma of neurons as having a high concentration of Nissl substance. Electron microscopy showed that Nissl substance is mainly what cell organelle?
   - A. chromosomes plus histones
   - B. mitochondria
   - C. microtubules
   - → D. rough endoplasmic reticulum
   - E. golgi apparatus

4. The sodium-potassium pump in neurons …
   - → A. is important for maintaining the resting membrane potential.
   - B. is activated by depolarization of the cell to generate and propagate an action potential.
   - C. pumps sodium ions (Na^+) into the cell and potassium ions (K^+) out of the cell.
   - D. is activated by excitatory synapses.
   - E. generates energy in the form of ATP for the neuron.

Class 3 & 4 embryology

5. What cell group is deep to the midline of the neural plate in the early mammalian embryo?
   - A. epidermis
   - B. somite
   - C. epiblast
   - D. hypoblast
   - → E. notochord

6. The diencephalon develops from what part of the early embryonic neural tube?
   A. telencephalon
   B. mesencephalon
→ C. prosencephalon
   D. rhombencephalon
   E. metencephalon

7. The hypothalamus is part of the …
   A. mesencephalon
   B. myelencephalon
   C. metencephalon
→ D. diencephalon
   E. More than one of the above are correct.

8. Which of the following best describes the location of cells in the neural plate that are likely to become neural crest cells?
   A. midline
→ B. lateral margin
   C. a stripe between the lateral margin and the midline
   D. the top furthest from the primitive streak
   E. the bottom closest to the primitive streak

9. Which of the following cell types does NOT normally develop from neural crest cells?
   A. sensory neurons
   B. sympathetic ganglion neurons
   C. melanocytes
→ D. epidermis
   E. More than one of the above do not develop from neural crest.

10. The hypothalamic sulcus divides the hypothalamus from the …
→ A. thalamus.
   B. neocortex.
   C. hippocampus.
   D. basal ganglia.
   E. The hypothalamic sulcus is not near the hypothalamus.

11. Imagine that you are in the laboratory examining a gross human brainstem with the cerebellum removed. When you examine the floor of the fourth ventricle, you see a midline crease running the length of the fourth ventricle and a series of bumps on either side of the crease. These bumps would be motor nuclei in upper medulla and pons. True or false?
→ A. true
   B. false

12. Neurons that develop from what region of the neural tube are most likely to have axons in the peripheral nervous system?
   A. alar plate
   B. floor plate
→ C. basal plate
   D. roof plate
   E. sulcus limitans

Class 5 induction

13. If you transplanted a region from the animal cap of an early blastula stage frog embryo into a region that would normally develop into skin of another embryo of the same age, what would you expect to see over the next day?
    A. The transplanted cells would develop into mesoderm, and the host cells around the transplant would develop into nervous system.
    B. The transplanted cells would develop into mesoderm, and the host cells around the transplant would develop into skin.
    C. The transplanted cells would develop into nervous system, and the host cells around the transplant would develop into skin.
→ D. The transplanted cells would develop into skin, and the host cells around the transplant would develop into skin.
    E. The transplanted cells would develop into skin, and the host cells around the transplant would develop into nervous system.

14. Activation of the BMP receptor results in activation of which of the following signaling systems?
    A. ERK
→ B. SMAD
    C. Gli
    D. STAT
    E. CREB

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

Class 6 regionalization I (from Dr. Nakagawa)

16. Which of the following is NOT true about Wnt signaling in regionalization?
    A. It is part of the caudalization signal duding early regionalization.
    B. Cerberus is one of the inhibitors of Wnt signaling.
    C. Frizzled/LRP6 forms a co-receptor for Wnts.
→ D. Beta-catenin is degraded when Wnt ligands bind to their receptors.
    E. TCF/LEF factors are the major transcription factors that regulate gene expression downstream of Wnt signaling.

17. Which of the following statements is NOT true about the axial mesoderm during early vertebrate development?
    A. It is derived from the organizer and can induce neural tissue.
    B. It expresses enzymes for synthesis of retinoic acid.
    C. It expresses Sonic hedgehog, which has a role in dorsal-ventral patterning of the neural tube.
    D. It later forms the somites.
→BD E. More than one of the above statements are not true.

18. Which of the following statements is TRUE about homeotic mutations and homeotic selector genes?
    A. Homeotic mutations transform parts of the body into structures appropriate for other positions.
    B. All homeobox genes are clustered together on chromosomes and their order on the chromosomes are similar to the order of their expression along the anterior-posterior axis.
    C. In the mouse, there are four clusters of Hox genes, and all of them are expressed exclusively in the hindbrain or the spinal cord.
    D. The homeodomain is a conserved DNA-binding domain.
→AD E. More than one of the above statements are true.

19. Which of the following statements is NOT true about the anterior-posterior patterning in Drosophila embryos?
    A. A large-scale screening of mutants resulted in the identification of many important genes and pathways.
    B. Gap genes like Hunchback and Krüppel map out the coarse subdivisions of the fly embryos.
    C. Expression of pair-rule genes is controlled by the combinatorial actions of upstream transcription factors.
    D. Segment polarity genes stabilize boundaries between segments.
→ E. All of the above are true.

Class 7 regionalization II (from Dr. Nakagawa)

20. Which of the following statements is NOT true about the isthmic organizer?
    A. Mutual repression between the transcription factors Otx2 and Gbx2 are important for its formation.
    B. It later contributes to the cerebellum.
    C. Its transplantation into the caudal diencephalon resulted in the induction of ectopic midbrain.
→ D. It secretes Sonic hedgehog.
    E. More than one of the above are NOT true.

21. Which of the following statements is NOT true about the segmental organization of the hindbrain?
→ A. A reduced level of retinoic acid signaling results in the expansion of the caudal hindbrain at the expense of the rostral hindbrain.
    B. The rostral border of *Hox* gene expression in the hindbrain is defined by signals from the isthmic organizer.
    C. Deletion or ectopic expression of Hox genes sometimes changes segmental identity of the hindbrain.
    D. All of the above are true.

[Everyone received credit for question 22.]

22. Which of the following statements is NOT true about *in vitro* generation of neurons from pluripotent stem cells?
→ A. Induced pluripotent stem cells (iPSCs) can be derived only from neural stem cells.
    B. Sequentially treating iPSCs with Wnt inhibitors and then SHH inhibitors will enhance the generation of cortical excitatory neurons.
    C. Fibroblasts can be directly converted into neurons.
    D. Adding BMP to embryonic stem cells inhibits the formation of neural cells.
    E. More than one of the above are not true.

23. Which of the following statements is NOT true about dorsal-ventral patterning?
    A. The spinal cord is divided into discrete domains of progenitor cells along the dorsal-ventral axis.
    B. The floor plate requires Sonic hedgehog for its formation, and in turn, it secretes Sonic hedgehog that induces ventral cell fates in the neural tube.
→ C. Sensory neurons in the dorsal root ganglion are derived from the alar plate of the spinal cord.
    D. The basal plate will give rise to neurons that directly innervate skeletal muscles.
    E. All of the above are true.

Class 8 & 9 cell division

24. Which of the following statements regarding cell division in the embryonic neural tube is NOT true?
    A. The length of S, G2 and M phases of the cell cycle are relatively constant in all cells.
    B. The length of the cell cycle gradually increases as development progresses.
→ C. The difference between slow and fast dividing cells is typically the length of the G2 phase of the cell cycle.
    D. The average cell cycle length is about 12 hours.
    E. All of the above statements are true.

25. In a newborn mouse, what would be the effect on development of the neocortex if you administered a drug that kills the microglia?
→ A. The cortex would be larger than normal.
    B. The cortex would be smaller than normal.
    C. The cortex would have an abnormally high percentage of glial cells.
    D. The cortex would have an abnormally high percentage of inhibitory interneurons.
    E. The cortex would be normal in size and have the normal proportion of the various cell types.

26. Which of the following proteins must be expressed in a neural progenitor cell at a sufficient level for the cell to enter S-phase of the cell cycle?
    A. cyclin A
    B. cyclin D
    C. cyclin dependent kinase 4/6
    D. retinoblastoma protein (Rb)
→A/C E. More than one of the above are correct.

27. Numerous growth factors promote division of neural progenitor cells by activating a cell surface receptor tyrosine kinase (RTK). The activated RTK has what effect in these cells?
    A. phosphorylation of CREB
    B. stabilization of β-catenin
    C. degradation of β-catenin
    D. increased expression of cyclin D
→A/D E. More than one of the above are correct.

28. Retinoblastoma protein (Rb) normally …
    A. promotes cell division by activating E2F transcription factors.
→ B. inhibits cells division by sequestering E2F transcription factors.
    C. promotes cell division by activating DNA polymerase.
    B. inhibits cells division by degrading DNA polymerase.
    E. promotes cell division by inactivating cyclin dependent kinase inhibitor (CKI).

29. In the developing central nervous system, all mitosis (M-phase of the cell cycle) takes place near the ventricle. True or false?
    A. true
→ B. false

30. If you want to label cells that become postmitotic in the embryonic day 12 (E12) rat cortex, you could inject a pregnant rat when its embryos are at E12 with _____ . After the rats are born, you could identify the labeled cells in their cortex histologically. (Fill in the blank.)
    A. radioactive thymidine
    B. Ki67
    C. bromodeoxyuridine (BrdU)
    D. nestin
→ E. More than one of the above are correct.

Class 10 & 11 cell fate

31. Which of the following factors is responsible for inducing dorsal cell fates in the developing spinal cord?
    A. Sonic hedgehog
    B. neuregulin
    C. chordin
→ D. BMPs
    E. More than one of the above are correct.

32. Which of the following statements is true regarding the sonic hedgehog (Shh) signal transduction pathway?
    A. Shh directly interacts with its receptor, Smoothened.
    B. Active Patched directly activates Gli transcription factors.
    C. Shh results in activated Patched.
→ D. Shh results in activated Smoothened.
    E. More than one of the above are correct.

33. BMP2 induces sympathetic ganglion neuronal fate. What is the key effect of BMP2 on the neural crest cells relative to specification of cell fate?
    A. Promotes expression of Neuregulin-1.
    B. Promotes expression of the Notch ligand, Delta1
    C. Promotes expression of integrins that bind fibronectin.
→ D. Promotes expression of certain transcription factors including Ash1 (Mash1 in mouse).
    E. More than one of the above is correct.

34. Which of the following statements regarding Notch is true?
    A. Notch is a secreted protein.
→ B. When Notch is activated, it is cleaved by proteases.
    C. When Notch is activated in neural progenitor cells, it promotes expression of proneural genes.
    D. Notch activation in neural progenitor cells represses generation of later produced cell types in favor of production of earlier produced cell types.
    E. More than one of the above is correct.

35. In developing neural tube at the level of the future spinal cord, the highest concentration of sonic hedgehog (Shh) normally induces …
    A. roof plate
→ B. floor plate
    C. alar plate
    D. basal plate

36. Rod photoreceptors are generated just after birth in the rodent retina. Imagine that you could isolate progenitor cells from the newborn retina and transplant them to an embryonic day 12 retina, an age at which ganglion cells are just starting to be born. What cell type(s) would you expect the transplanted progenitor cells to generate?
    A. mainly retinal ganglion cells
    B. mainly retinal ganglion cells first and then probably other retinal cell types
→ C. mainly rod photoreceptor cells first and then possibly glia
    D. The transplanted cells would most likely be inhibited from generating differentiating cells in the new environment.

37. Proneural factors …
→ A. bind E-box sequences in the regulatory regions of target genes.
    B. promote neural progenitor cell division.
    C. are expressed as the result of Notch activation.
    D. bind the Notch protein and block Notch signaling.
    E. More than one of the above are correct.

Class 12 research (from Dr. Nakagawa)

38. Which of the following statements is NOT true about the thalamus?
    A. The adult thalamus not only relays sensory information to the cortex, but also connects different cortical areas.
→ B. All thalamic neurons are excitatory neurons that project axons to the cerebral cortex.
    C. Nuclear identity of thalamic progenitor cells is already specified in radial glial cells.
    D. Individual radial glial cells in the thalamus populate more than one thalamic nuclei.
    E. All of the above are true.

Class 13 discussion

39. Which of the following is true regarding the developing neural tube?
    A. Shh signaling via activated Gli proteins directly promotes expression of cyclin D1.
    B. Wnt signaling via activated Gli proteins directly promotes expression of cyclin D1.
    C. Shh signaling via activated Gli proteins directly promotes expression of Wnt.
→ D. Shh signaling is required for expression of Tcf3/4.
    E. More than one of the above are correct.

Class 14 research (from Dr. Lanier)

40. 'Typical' signaling from the D1 and D2 dopamine receptors involves …
    A. activation of PKC.
→ B. changing activity of adenylyl cyclase.
    C. inhibiting CaMKII.
    D. More than one of the above are correct.

The End!

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