Name _____KEY_____

Nsci 4100: Development of the Nervous System
2017 Examination 2

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

Class 17 & 18 cell migration

1. Collagens are composed of …
   - A. unbranched chains of polysaccharide.
   - B. polysaccharide chains bonded to a protein core.
   - → C. three polypeptides complexed with one another.
   - D. proteoglycans.

2. Cadherins …
   - A. activate integrins.
   - → B. require calcium to bind.
   - C. are GPI-linked cell surface proteins.
   - D. are components of the extracellular matrix.
   - E. More than one of the above are correct.

3. Which of the following statements is true regarding induction of neural crest cells?
   - A. Mesodermal cells induced to be neural crest down-regulate expression of the transcription factor Snail.
   - B. Induction of neural crest requires BMPs from mesodermal cells in the midline of the embryo.
   - C. Induction of neural crest requires FGF from the lateral ectoderm.
   - → D. Cells induced to be neural crest are described as delaminating from the neural tube.
   - E. More than one of the above are correct.

4. What do the very last cells to migrate from the neural crest in the trunk region become?
   - → A. pigment cells of the skin
   - B. autonomic ganglion neurons
   - C. dorsal root ganglion neurons
   - D. Schwann cells (glia of the PNS)
   - E. skeletal muscles

5. The arg-gly-asp (RGD) amino acid sequence is an important part of what type of molecule?
   - A. the β-chain of integrin
   - B. the collagen binding domain of fibronectin
   - → C. the cell binding domain of fibronectin
   - D. the intracellular domain of notch

6. SDF1 (Cxcl12) …
   - A. attracts migrating neural crest cells that form sympathetic ganglia.
   - B. repels early migrating neural crest cells from taking the dorsolateral pathway.
   - C. repels migrating neural crest cells from entering the caudal half of sclerotomes.
   - D. attracts migrating interneurons into the developing cerebral cortex.
   - →AD E. More than one of the above are correct.

7. In the developing cerebellum, …
   A. progenitor cells migrate from the medulla into the cerebellar plate.
   B. postmitotic neurons migrate from the mitotic layer at the pial surface towards the ventricular layer.
   C. postmitotic neurons migrate from the mitotic layer at the ventricular surface towards the pial surface.
   D. postmitotic neurons migrate from the cerebellar plate into the pons.
→BC E. More than one of the above are correct.

8. Cells that secrete reelin in the embryonic cortex are found in what layer?
   A. cortical plate
   B. subplate
   C. ventricular zone
→ D. marginal zone
   E. subventricular zone

Class 19 research from Gammill

9. Which of the following statements is true regarding the role of NSD3-related lysine methyltransferase (NSD3) in neural crest development?
   A. NSD3 is expressed by non-neural crest cells in the dorsal neural tube.
   B. NSD3 is required for neural crest cells to migrate.
   C. NSD3 promotes expression of the transcription factor Snail2 by neural crest cells.
   D. NSD3 is expressed in somites and appears to repel migrating neural crest cells.
→BC E. More than one of the above are correct.

Class 20 cell movement

10. The hallmark of lissencephaly is defective …
   A. brain patterning.
→ B. cell migration.
   C. cell division.
   D. axon growth.
   E. cell adhesion.

11. Migrating cells form plaques of tight membrane adhesion to elements in their environment. These patches are coincident with intracellular concentrations of …
   A. microtubules
   B. neurofilaments (intermediate filaments)
→ C. actin filaments
   D. collagen filaments
   E. More than one of the above are correct.

12. Which of the following is true regarding a migrating cell?
   A. The plus end of microtubules is oriented towards the leading front of the cell.
   B. The centrosome is typically on the trailing side of the nucleus.
   C. The plus end of the microtubules is oriented towards the trailing end of the cell.
   D. The centrosome is a site of nucleation for actin filaments.
→AC E. More than one of the above are correct.

13. Cell migration involves three steps, traction, protrusion, and adhesion, not necessarily in that order. Three proteins, Ena/VASP, myosin II and integrin, were each described as being involved in a step of cell migration. Which sequence below places these proteins in the correct order for the three steps of cell migration, as presented in class?
    A. integrin, Ena/VASP, myosin II
    B. Ena/VASP, myosin II, integrin
→ C. Ena/VASP, integrin, myosin II
    D. integrin, myosin II, Ena/VASP
    E. Myosin II, Ena/VASP, integrin

Class 21 neurite initiation

14. Which of the following statements regarding microtubules is true?
    A. Microtubules grow by polymerization only at their plus ends.
    B. Microtubules shrink by catastrophe only at their minus ends.
    C. Microtubule-associated proteins (MAPs) regulate microtubule stability.
    D. ATP must be bound to tubulin dimers in order for the tubulin dimer to be added to a microtubule.
→AC E. More than one of the above are correct.

15. Which of the following is NOT a motor protein that can 'walk' along a microtubule by a change in conformation?
    A. myosin II
    B. dynein
    C. kinesin
    D. actin
→AD E. More than one of the above are correct.

16. Axons grow in length by …
    A. adding membrane at the growth cone.
    B. adding membrane along the mid-shaft of the axon.
    C. pulling membrane out of the soma at the start of the axon.
→AB D. More than one of the above are correct.

17. Which of the following statements describes a characteristic of the cell process that becomes the axon in a developing neuron in tissue culture?
    A. The first process that extends from the cell will usually become the axon.
    B. The axon usually forms on the side of the soma opposite to the side with the centrosome.
    C. The axon usually forms on the same side of the soma as the Golgi apparatus.
    D. The only cell process with membrane vesicles will become the axon.
→AC E. More than one of the above are correct.

Class 22-23 axon guidance

18. Treating growing axons with cytochalasin B to block actin polymerization would …
    A. result in immediate and complete retraction of the axon.
    B. prevent further axon extension.
→ C. not stop further axon extension, but axons would not respond to guidance cues.
    D. have very little effect on axon extension or guidance.

19. Molecules that function as attractive guidance cues for axons growing in the nervous system are always bound to the ECM or cell surfaces, while repulsive guidance factors are typically secreted diffusible molecules. True or false?
    A. true
→ B. false

20. Dr. McLoon ablated the optic tectum in chick embryos prior to the arrival of the retinal axons in the brain as part of his thesis project. After the ablation, once they entered the brain, the retinal axons …
    A. stopped extending.
    B. continued to extend, but in no particular direction. (They appeared to lack guidance.)
→ C. continued to extend in the normal direction in the optic tract.

21. Which of the following statements is correct regarding the role of GDNF in the growth of spinal motor neuron axons into limb bud in developing vertebrate embryos?
→ A. GDNF attracts the growing axons towards the limb.
  B. GDNF repels the growing axons into a tight pathway prior to their entering the limb.
  C. GDNF is expressed in the ventral limb compartment and attracts the ventral axons.
  D. GDNF is expressed in the dorsal limb compartment and repels the ventral axons.

22. In Drosophila, which of the following statements correctly describes the role of netrin in development of connections between certain motor neurons and their muscles?
    A. Netrin is expressed by a subset of muscle cells and attracts certain motor axons.
    B. Netrin is expressed by a subset of muscle cells and repels certain motor axons.
    C. Netrin is expressed by a subset of motor neurons and mediates attraction to certain muscle cells.
    D. Netrin is expressed by a subset of motor neurons and mediates repulsion by certain muscle cells.
→AB E. More than one of the above are correct.

23. Which of the following statements is correct regarding the growth of spinal motor neuron axons into the limb bud in developing vertebrate embryos?
    A. EphBs are expressed by cells in the dorsal limb compartment, and they attract dorsal axons.
    B. EphBs are expressed by cells in the dorsal limb compartment, and they repel ventral axons.
    C. EphrinBs are expressed by cells in the dorsal limb compartment, and they attract dorsal axons.
→ D. EphrinBs are expressed by cells in the dorsal limb compartment, and they repel ventral axons.
    E. EphAs and EphrinAs are expressed by cells in the dorsal limb compartment. EphAs attract dorsal axons, and ephrinAs repel ventral axons.

24. Inactivation of cofilin on one side of a growth cone would result in …
    A. the growth cone turning towards the side with the inactive cofilin.
→ B. the growth cone turning away from the side with inactive cofilin.
    C. the entire growth cone retracting.
    D. the growth cone speeding up extension without significant turning.
    E. the growth cone freezing.

25. Commissural neurons in the dorsal horn of the vertebrate spinal cord have axons that cross the midline in the floor plate and then ascend to the brain. Which of the following statements regarding these neurons is NOT correct?
    A. These axons are repelled by Slit expressed in the floor plate.
    B. These axons are attracted to Netrin expressed in the floor plate.
→ C. Robo1 is activated in these axons until they cross the midline.
    D. Robo3 expression is downregulated after these axons cross the midline.
    E. More than one of the above are NOT correct.

Class 24-25 specificity

26. In humans, visual information originating from the right eye is largely processed …
    A. on the right side of the brain.
    B. on the left side of the brain.
→ C. with about half the information going to the right side and half to the left side of the brain.
    D. with most of the information going to both sides of the brain except for information from a portion of one quadrant of the retina, which goes only to the right side of the brain.

27. How do growing axons change as they enter their appropriate target region?
    A. The amount of polysialic acid (PSA) associated with Ig-CAMs on the growing axons decreases.
    B. The axons become more fasciculated.
    C. The rate of axon extension increases.
→ D. The growth cones and axons become more complex and branched.
    E. More than one of the above are correct.

28. Eph proteins are …
→ A. receptor tyrosine kinases.
    B. ligands for Trk receptors.
    C. secreted, and often function in gradients.
    D. extracellular matrix proteins found in some parts of the developing nervous system.
    E. More than one of the above are correct.

29. Imagine that you created a transgenic mouse in which the gene for the olfactory receptor protein OR10J2 was replaced with the OR10J5-GFP gene. The promoter for OR10J2 was left in place upstream of the OR10J5-GFP transgene. Where will the axons of the GFP+ olfactory receptor neurons connect?
    A. Most likely they will not make connections.
    B. They will connect with the OR10J2 glomeruli in the olfactory bulb.
→ C. They will connect with the OR10J5 glomeruli in the olfactory bulb.
    D. They will connect randomly with the OR10J2 and OR10J5 glomeruli in the olfactory bulb.
    E. They will connect randomly with any of the glomeruli in the olfactory bulb.

30. Numerous mechanisms have been proposed to account for development of topographic specificity between axons and target cells. Which of the proposed mechanisms seems particularly unlikely to have a role in development of retinotopic connections in the tectum?
    A. Selective retention of appropriate connections based on functional validation.
    B. Axon-non-target cell aversion.
    C. Axon-target cell affinity.
    D. Axon-axon sorting.
→ E. Timing of axon ingrowth relative to maturation of target cells.

31. There is evidence that ephrinAs at low concentrations promote retinal axon growth and at higher concentrations, stop retinal axon growth. What mechanism could account for the difference?
→ A. An increased concentration of ephrinAs could in some way lead to a loss of cGMP in the retinal axon growth cones.
    B. An increased concentration of ephrinAs could in some way activate PKA in the retinal axon growth cones.
    C. An increased concentration of ephrinAs could in some way increase the concentration of calcium ions in the retinal axon growth cones.
    D. More than one of the above are correct.

32. Axons of retinal ganglion cells synapse in multiple locations in the brain. Which of the following is NOT one of those locations?
    A. suprachiasmatic nucleus in the hypothalamus
    B. lateral geniculate nucleus in the thalamus
    C. superior colliculus in the midbrain
→ D. occipital cortex

33. Bonhoeffer and associates created a substrate on a tissue culture dish with alternating stripes of cell membranes harvested from the anterior and posterior thirds of chick tectum. They grew explants from the far nasal or far temporal regions of the retina on this substrate. Which of the following statements best describes the growth of the axons from the explants on this substrate? [Axons from the temporal side of the retina normally synapse in anterior tectum; nasal retinal axons synapse in posterior tectum.]
    A. Axons from the temporal side of the retina grew selectively on the membranes from the anterior tectum due to a high affinity of these axons for these membranes.
    B. Axons from the nasal side of the retina grew selectively on the membranes from the posterior tectum due to a high affinity of these axons for these membranes.
→ C. Axons from the temporal side of the retina grew selectively on the membranes from the anterior tectum because they were repelled by the posterior tectal membranes.
    D. Axons from the nasal side of the retina grew selectively on the membranes from the posterior tectum because they were repelled by the anterior tectal membranes.
    E. More than one of the above are correct.

Class 26 synapse formation

34. What neurotransmitter is used by motor neurons to activate skeletal muscles?
    A. glutamate
    B. GABA
→ C. acetylcholine
    D. noradrenalin
    E. adrenalin

35. Which of the following statements regarding the development of the electrical properties of neurons is true?
    A. The resting membrane potential of neurons becomes more negative as development progresses.
    B. The resting membrane potential of neurons becomes more positive as development progresses.
    C. Voltage-gated sodium channels mediate the first action potentials developmentally, but these channels are lost as other types of voltage-gated channels are expressed.
    D. The concentration of potassium ions (K^+) in the extracellular space of the brain decreases as development progresses.
→AD E. More than one of the above are correct.

36. In development of neuromuscular junctions, what molecule is released from the growth cones of the motor neurons that initiates clustering of neurotransmitter receptors in the muscle membrane and other aspects of synapse development?
    A. MuSK
    B. Rapsyn
    C. Low density lipoprotein receptor-related protein 4 (LRP4)
→ D. Agrin
    E. Dystroglycan

37. Synaptogenesis typically begins with formation of adherens junctions. What family of molecules are responsible for these junctions?
    A. connexons
→ B. cadherins and protocadherins
    C. integrins
    D. neurexins and neuroligins

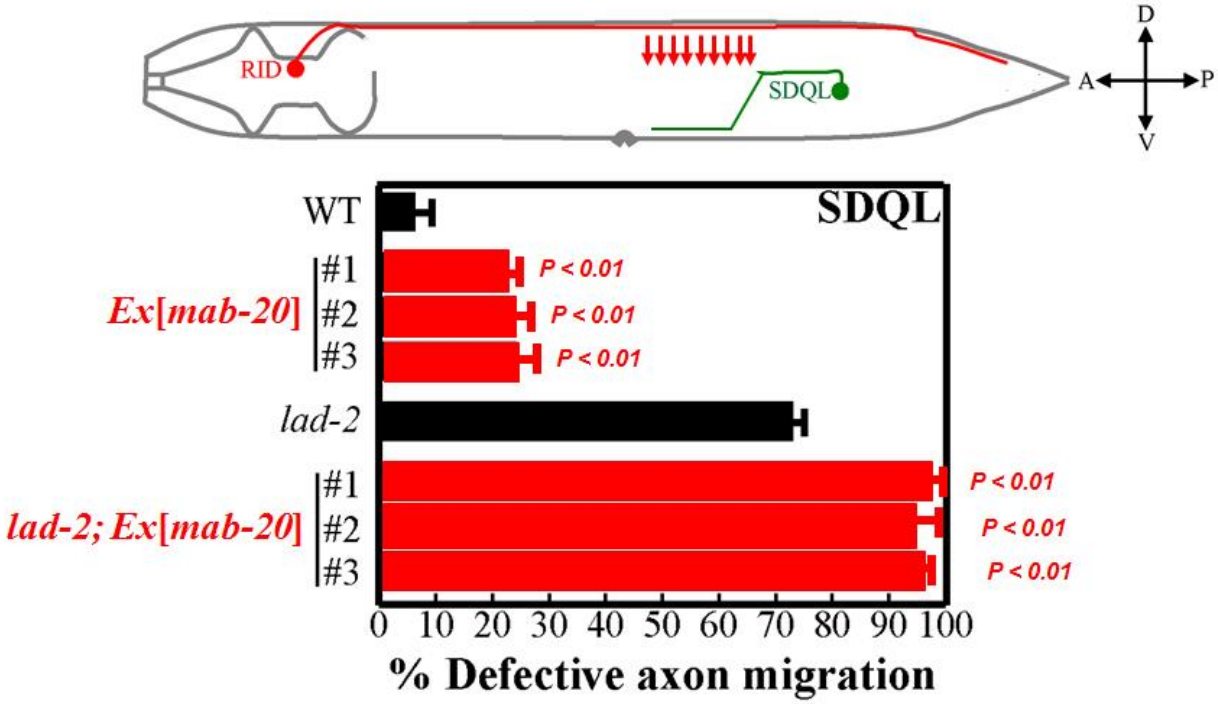
38. Which of the following proteins binds directly to postsynaptic density protein-95 (PSD95) at synaptic sites in the brain?
    A. neuroligin
    B. neurexin
    C. synaptotagmin (a protein associated with synaptic vesicles)
    D. NMDAR (a glutamate receptor)
→AD E. More than one of the above are correct.

Class 28 paper discussion

39. Misexpression of the transcription factor Zic2 in all retinal ganglion cells starting as soon as they begin to differentiate would likely have what effect on the developing visual system?
→ A. Virtually all retinal axons would project to visual nuclei on the ipsilateral side of the brain.
    B. Virtually all retinal axons would project to visual nuclei on the contralateral side of the brain.
    C. Virtually all retinal axons would fail to exit the eye.
    D. Virtually all retinal axons would fail to stop in the superior colliculus and would grow into the inferior colliculus.
    E. More than one of the above are correct.

Class 27 research from Chen

40. Results of dorsal MAB-20 expression in the RID neuron on SDQL axon trajectory in wild-type and loss-of-function *lad-2* animals is shown below. Which of the following best explains the data?
    A. MAB-20 acts as an attractive signal to the SDQL axon.
    B. LAD-2 acts as an attractive signal to the SDQL axon.
→ C. MAB-20 can mediate axon guidance independent of LAD-2.
    D. LAD-2 is required to mediate mab-20 function in mediating axon migration.



The End!

Please <u>turn in this exam and your bubble sheet</u> in the box at the back of the room.

Double check that your name is on both.