Name _____KEY_____

Nsci 4100: Development of the Nervous System
2018 Examination 2

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 19 & 20 cell migration

1. Which of the following is NOT true regarding neural crest cells?
→ A. Crest cells are induced by a high concentration of Shh.
B. Crest cells undergo an epithelial-to-mesenchymal transformation in response to increased expression of Snail and Slug.
C. Crest cells develop at the lateral margin of the neural plate.
D. Of all cells induced to be neural, crest cells are exposed to the highest concentration of BMP4 and the lowest concentration of BMP inhibitors.
E. More than one of the above are NOT true.

2. The earliest neural crest cells to migrate develop into what cell type?
A. sensory ganglion neurons
→ B. autonomic ganglion neurons
C. motor neurons
D. melanocytes
E. sensory neurons of the dorsal horn of the spinal cord

3. There are two sub-families of integrins, α and β. Cells express one or the other, but not both. True or false?
A. true
→ B. false

4. Certain populations of migrating crest cells …
→ A. express the receptor, Cxcr4, on their cell surfaces.
B. are repelled by Cxcr4.
C. follow an increasing soluble gradient of Cxcr4.
D. secrete Cxcr4, which induces gliogenesis in other crest cells.

5. Which of the following is NOT true regarding radial glia?
A. Radial glia typically span the entire thickness of the neural tube.
B. Radial glia are progenitor cells (dividing cells) that give rise only to glia.
C. Radial glia can serve as the adhesive substrate for certain migrating cells.
D. Certain radial glia secrete Reelin.
→BD E. More than one of the above are NOT true.

6. Which of the following is true regarding cells in the developing cerebral cortex?
A. There is a sequential generation of cortical cell layers starting with the layer closest to the pial suface and ending with the deepest layer.
B. Cells in the subplate secrete Reelin.
C. Most radial glia undergo mitosis in the subventricular zone (layer).
→ D. The first cells to become postmitotic form the preplate.
E. More than one of the above are true.

7. Which of the following is true regarding Lis1 in the developing cerebral cortex?
    A. Lis1 activates Dab1.
    B. Lis1 regulates the activity of dynein in migrating cells.
    C. Mutations in Lis1 can result in heterotopias in the cortex.
    D. Lis1 has an important role in ending cell migration.
→BC E. More than one of the above are true.

8. Tangential (or circumferential) cell migration in the developing telencephalon gives rise to what cell type?
    A. medium spiny neurons in the caudate nucleus (part of the striatum)
    B. projection neurons in the globus pallidus
→ C. inhibitory interneurons in the neocortex
    D. pyramidal neurons in the neocortex
    E. More than one of the above are correct.

Everyone received credit for question 9.

9. In the developing cerebellum, most neurons are produced by division of progenitor cells that divide near the pial surface. True or false?
→ A. true
    B. false

Class 21 cell movement

10. Adhesion dependent cell migration is described as having three steps. Which of the following is the best description of the first step?
    A. adhesion
    B. traction
→ C. protrusion
    D. initiation
    E. consolidation

11. In adult humans, cells that develop from neural crest can become motile again. This can be associated with what disease?
    A. lissencephaly
→ B. malignant melanoma
    C. cortical heterotopias
    D. aganglionic megacolon
    E. albinism

12. *Dynein typically transports cargo in an axon towards the cell body. True or false?
→ A. true
    B. false

13. Protrusion of the cell membrane at the leading edge of a migrating cell is due to polymerization of …
    A. myosin.
→ B. actin.
    C. Ena/VASP.
    D. tubulin.
    E. intermediate filaments.

14. What must be bound to tubulin dimers in order for them to polymerize into microtubules?
    A. ADP
    B. ATP
→ C. GTP
    D. glucose
    E. None of the above are required.

15. Which of the following is true regarding the position of the centrosome in a migrating cell?
→ A. The centrosome is in front of the nucleus on the side towards the leading edge of the cell.
    B. The centrosome is behind the nucleus on the side towards the trailing edge of the cell.
    C. The centrosome is in the leading edge of the cell.
    D. The centrosome is in no particular place in a migrating cell.

Class 22 neurite initiation

16. Which of the following is the least dynamic cytoskeletal structure in an axon?
    A. actin filaments
→ B. neurofilaments
    C. microtubules
    D. axofilaments
    E. axotubules

Answers A or E were accepted for question 17 due to a grading error.

17. Which of the following promotes formation of a neurite by a developing neuron?
    A. insertion of microtubules into a filopodia
    B. insertion of actin filaments into a filopodia
    C. inactivation of myosin
    D. inactivation of Ena/VASP
→AC E. More than one of the above are correct.

18. Ena/VASP promotes actin polymerization, which can result in elongation of a filopodia on a neuron. True or false?
→ A. true
    B. false

19. Which of the following is important for linking actin filaments to integrin adhesion sites in a growing axon?
    A. alpha-actinin
    B. vinculin
    C. talin
    D. catenins
→BC E. More than one of the above are correct.

20. An axon can branch by …
    A. the growth cone splitting.
    B. formation of a protrusion along the axon shaft.
    C. by initiation of a second axon from the soma, the proximal portion of which can fuse with the initial axon.
    D. Axons do not normally branch.
→AB E. More than one of the above are correct.

Class 23-24 axon guidance

21. Which of the following is NOT an important mechanism for guiding growing axons?
    A. contact adhesion
    B. contact repulsion
    C. secreted attractive molecule that acts at a distance from its source
    D. secreted repulsive molecule that acts at a distance from its source
→ E. None of the above are correct as all are important guidance mechanisms.

22. What defect in the nervous system was present in Drosophila lacking the fasciclin II gene?
    A. certain axons inappropriately did not cross the midline
    B. certain axons inappropriately crossed and recrossed the midline
    C. certain axons grew inappropriately towards the back end of the embryo instead of towards the head
→ D. certain axons did not form bundles; instead, they remained largely solitary

23. Mauthner cells are large neurons in the hindbrain of larval fish and amphibians. These neurons send their axons posteriorly to the spinal cord. A segment of the hindbrain containing these cells can be surgically rotated in larvae. What will the growing axons of these cells do after the rotation?
    A. They will grow anteriorly into the midbrain.
→ B. They will grow anteriorly until they encounter tissue that has not been rotated. Then they will turn and grow posteriorly into the spinal cord.
    C. They will grow posteriorly into the spinal cord.
    D. They will not exit the rotated piece of hindbrain.

24. Commissural neurons in vertebrate spinal cord grow axons towards the floor plate, where they cross the midline and then turn to grow towards the brain without recrossing the midline. What role does slit play in the process?
    A. attracts axons to the floor plate
→ B. prevents axons from recrossing the midline after they have crossed
    C. attracts axons towards the brain
    D. cell surface receptor that mediates repulsion to a guidance cue
    E. cell surface receptor that mediates attraction to a guidance cue

25. *Some migrating cells use laminin as an adhesive substrate. What type of membrane protein is involved in this type of adhesion?
    A. Cadherins
    B. Ig-like CAMs
→ C. Integrins
    D. EphA
    E. More than one of the above are correct.

26. Which of the following is activated in growth cones by a repulsive guidance cue?
    A. Cofilin
    B. Rac
    C. RhoA
    D. Myosin II
→CD E. More than one of the above are correct.

27. Motor neurons in the lateral motor column (LMC) of the ventral horn of the sacral spinal cord innervate the leg muscles. Neurons in the lateral division of the LMC normally send axons to dorsal leg muscles, and neurons in the medial division of the LMC send axons to the ventral leg muscles. Which of the following statements is true regarding the guidance of LMC axons as they grow into the limb?

→ A. Axons destined for the dorsal limb expressing EphAs are repelled by ephrinAs in the ventral limb.
B. Axons destined for the ventral limb expressing ephrinAs are repelled by EphAs in the dorsal limb.
C. Axons destined for the dorsal limb expressing EphAs are attracted by ephrinAs in the dorsal limb.
D. Axons destined for the dorsal limb expressing semaphorin3F are repelled by cRET in the ventral limb.
E. More than one of the above are correct.

28. Which of the following is an important element of the clutch hypothesis?

A. Cell surface adhesion molecules such as integrin anchor actin filaments and prevent retrograde flow.
B. Depolymerization of microtubules stabilizes the filopodia.
C. Myosin retracts actin filaments from the filopodia.
D. Neurofilaments function as clutches to stop the retrograde flow of microtubules.
→AC E. More than one of the above are correct.

29. When an axonal growth cone encounters an attractive guidance cue on its right side …

A. microtubules polymerize preferentially on the right side of the growth cone.
B. microtubules continue to polymerize uniformly across the leading edge of the growth cone.
C. actin depolymerizes preferentially on the left side of the growth cone.
D. actin continues to polymerize uniformly across the leading edge of the growth cone.
→AC E. More than one of the above are correct.

Class 25-26 specificity

30. *In most cases, it is not known why a population of axons chooses the particular group of cells with which to form connections. What mechanism has been shown to be important in at least one case?

A. A molecule secreted by the target cells attracts the appropriate population of growing axons.
B. Homophilic interactions between cell adhesion molecules on the growing axons and the target cells allow the growing axons to enter the appropriate cell group.
C. Repulsive molecules funnel growing axons into the appropriate cell group.
D. Growing axons enter nearby cell groups indiscriminately, and then incorrect connections are secondarily eliminated by activity dependent mechanisms.
→all E. More than one of the above are correct.

31. A retinal axon expressing high levels of EphA5 growing in tissue culture most likely will avoid a stripe of what molecule bound to the culture dish?

A. EphB2
→ B. Ephrin-A2
C. Ephrin-B2
D. Zic2
E. More than one of the above are correct.

32. The oculomotor nerve (cranial nerve III) normally innervates four of the eye muscles. A recently published study found that in mice with a knockout of the CXCR4 gene or in mice treated with a drug that blocks CXCR4 function, the oculomotor axons grew in crazy directions and did not connect with the muscles. Which of the following do you predict to be true?
    A. Eye muscles express CXCR4.
→ B. Eye muscles express SDF1.
    C. oculomotor motor neurons express SDF1.
    D. Brainstem glia surrounding the motor neurons express SDF1.
    E. More than one of the above are most likely correct.

33. In most sensory systems, the pattern of axonal connections from one group of neurons to the next can be described as a map of the distribution of the cells giving rise to the axons. Which system is an exception to this rule?
    A. visual system
    B. auditory system
    C. somatosensory system
→ D. olfactory system
    E. None of the above is correct.

34. The adhesivity (stickiness) of an Ig-CAM is naturally reduced by what protein modification?
    A. reducing the amount of polysialic acid associated with the CAM
→ B. increasing the amount of polysialic acid associated with the CAM
    C. shortening the extracellular domain of the CAM
    D. shortening the cytoplasmic domain of the CAM

35. What changes are commonly seen in a growth cone once it enters its appropriate target cell population?
    A. The growth cone slows its advance.
    B. The growth cone speeds up its advance.
    C. The growth cone stops.
    D. The growth cone morphology becomes more complex.
→AD E. More than one of the above are correct.

36. In goldfish, retinal axons from the temporal side of the retina normally connect to the anterior region of the tectum, and retinal axons from the nasal side of the retina connect to the posterior region of the tectum. If the temporal side of a retina is removed and the optic nerve from that retina is crushed, the axons from the remaining nasal side of the retina will regenerate and connect with anterior regions of the tectum. True or false?
    A. true
→ B. false

37. Which of the following guidance molecules does not have a cytoplasmic domain?
    A. EphA2
→ B. Ephrin-A2
    C. Ephrin-B2
    D. More than one of the above are correct.
    E. None of the above are correct as all have cytoplasmic domains.

38. Which of the following statements regarding olfactory receptor proteins is NOT true?
    A. Humans typically express 339 different olfactory receptor proteins.
    B. Olfactory receptor neurons in the nasal epithelium express an olfactory receptor protein on their axons that grow into the brain.
    C. Olfactory receptor neurons in the nasal epithelium express an olfactory receptor protein on their dendrites.
→ D. Neurons in the olfactory bulb express an olfactory receptor protein on their axons that grow into the nasal epithelium.
    E. All of the above are true, and none are false.

Class 28 paper discussion

39. Retinal ganglion cells in the developing mouse retina that express Zic2 are likely to …
    A. send their axons to the ipsilateral side of the brain
    B. synapse with neurons in the posterior region of the superior colliculus
    C. express EphB1
    D. express Wnt3
→A/C E. More than one of the above are correct.

Class 29 research from Chen

Everyone received credit for question 40.

40. Which of the following is NOT true regarding L1?
→ A. L1 is a cadherin type cell adhesion molecule.
    B. Mutations in the L1 gene in humans have been linked to corpus callosum hypoplasia and hydrocephalus.
    C. L1 has a transmembrane domain.
    D. SAX-7 and LAD-2 are C. elegans L1-like molecules.
    E. More than one of the above are NOT correct.

The End!

Please turn in this exam and your scantron in the box at the back of the room.

Double check that your name is on both.