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NEUROSCIENCE
EXAM 2
FALL 2011

Multiple Choice: Read the <u>entire question</u> and <u>all answers</u> before choosing (circle the letter) <u>the one best answer</u>. Each question is worth 2 points.

1. With regard to the development of the CNS which of the following is/are **TRUE**?
a) Cleavage of a neuronal precursor cell in the vertical plane will give rise to two daughter neuronal precursor cells.
b) Cleavage of a neuronal precursor cell in the vertical plane will give rise to a daughter neuronal precursor cell and a neuron or glial cell.
c) Cleavage of a neuronal precursor cell in the horizontal plane will give rise to two daughter neuronal precursor cells.
d) Cleavage of a neuronal precursor cell in the horizontal plane will give rise to a daughter neuronal precursor cell and a neuron or glial cell.
e) both a and d are true
f) both b and c are true

2. Neurons that regulate the release of hormones from the pituitary gland are found in the _____.
a) Thalamus
b) Hypothalamus
c) Tectum of the midbrain
d) medulla
e) Dorsal column nuclei

3. Which of the following receives direct synaptic input from neurons in the olfactory bulb?
a) VPM of the thalamus
b) Amygdala
c) Orbitofrontal cortex
d) Olfactory tubercle
e) All of the above
e) Only b and d
f) Only b, c, and d

4. Which type of cortex consists of a single layer of neurons?
a) Insular cortex
b) Hippocampal cortex
c) Olfactory cortex
d) Isocortex
e) none of the above

5. The dorsal horn of the spinal cord:
(a) is composed of the cell bodies of dorsal root ganglion cells.
(b) receives sensory inputs from the dermatomes of the body.
(c) is composed of the neurons that send their axons out to innervate skeletal muscles.
(d) both a and b are true.
(e) none of the above are correct.

6. Which of the following develops from a secondary brain vesicle?
a) The cerebral hemispheres
b) The midbrain
c) The cerebellum
d) The pons
e) Both a and c

7. The _____ consists of axons that connect the neurons in one cerebral hemisphere with the neurons in the same cerebral hemisphere.
a) the cortical white matter
b) the corpus callosum
c) the internal capsule
d) the lateral column
e) the intracerebral column

8. The basal ganglia developmentally is derived from the _____.
a) Prosencephalon
b) Diencephalon
c) Mesencephalon
d) Rhombencephalon
e) Thalamus

9. The axons that carry motor commands from the brain to the motor neurons and motor circuits in the spinal cord are part of the _____
a) dorsal column white matter
b) internal capsule
c) lateral white column
d) a and b
e) b and c

10. The primary gustatory cortex is also known as Brodmann area _____.
a) 17 & 18
b) 3,1,2
c) 52
d) 43
e) None of the above

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11. The primary gustatory cortex is found on the _____.
a) frontal lobe
b) precentral gyrus
c) insular cortex
d) temporal lobe
e) none of the above

12.The primary sensory cortex:
a) is found on the precentral gyrus
b) is part of the parietal lobe
c) is part of the temporal lobe
d) both a and b
e) none of the above

13.The part of the ventricular system found in the midbrain is called the ____.
a) first ventricle
b) second ventricle
c) third ventricle
d) fourth ventricle
e) cerebral aqueduct

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Matching: From the list below select the word that best matches the numbered item and place the letter next to the numbered item. Not all words in the list are used, and some may be used more than once. Each question is worth 2 points.

a) Cerebellum
b) Hypothalamus
c) Thalamus
d) Medulla oblongata
e) Midbrain
f) Pons

_D__14. This is the part of the brain where you would find the primary gustatory nucleus, where the gustatory afferent axons synapse.

_C__15. Most sensory information reaching the isocortex is relayed by neurons in this part of the brain.

_A__ 16. This primary function of this part of the brain is the coordination of skeletal muscles

_B__ 17. This part of the brain coordinates involuntary functions like body temperature and behavioral drives.

_D__ 18. This part of the brain has autonomic centers that control breathing, blood pressure, and heart rate.

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<u>TRUE/FALSE</u>. Circle T if the statement is true. Circle F if the statement is false. For false statements you must cross out the word or words that make the statement false and replace them with a word or words to make a true statement. <u>You may not</u> add words to the sentence to make it true. <u>You may not</u> cross out the entire statement in constructing a true statement. (Each is worth 2 point)

east

<u>Example</u>: T (F) The sun rises in the ~~west~~.

Anterior ----------or----------tectum

19. T **F** The **~~posterior~~** portion of this part of the brain is called the **~~tegmentum~~**.

temporal

20. T **F** The olfactory cortex is part of the **~~frontal~~** lobe.

frontal

21. T **F** The central sulcus marks the boundary between the parietal and **~~occipital~~** lobes.

22. **T** F The trigeminal nerve conveys the sense of touch from the tongue.

salty or sour ---or---- ATP

23. T **F** Taste receptors most sensitive to **~~sweet~~** stimuli use **~~serotonin~~** as their neurotransmitter.

forebrain

24. T **F** The basal ganglia are part of the **~~midbrain~~**.

25. **T** F The facial nerve provides motor innervations to the muscles of facial expression.

Short Answer and Essay Questions:

26. Define the following terms (each is worth 2 points):

Neural crest cells:
A set of cells derived from the ectoderm that the neural folds during neuralation that differentiate into the neurons and glia of the PNS, as well as other types of cells.

Isocortex:
Cortex consisting of six cell layers, found only in mammals and making up the bulk of the cerebral hemispheres.

Fungiform papillae:
Small, mushroom like bumps on the surface of the anterior 2/3rd of the tongue on which taste buds are found.

Primary brain vesicle:
Three expansions (the prosencephalon, mesencephalon, and rhombencephalon) of the rostral-end of the neural tube that develop into the brain.

Rhombic lip:
Roof of the rostral rhombencephalon that develops into the cerebellum.

Population coding:
The interpretation by the brain of a specific sensory stimulus based on the differential activation of a population of sensory receptors.

Gustducin:
A G protein linked to the sweet, umami, and bitter taste receptors that is activated when a taste molecule binds to a the receptor expressed on the cell membrane of a taste receptor cell. Activation of the gustducin protein in turn activates a second messenger system leading to the release of ATP neurotransmitter on to the sensory afferent axon innervating the taste receptor cell.

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27. Describe signal transduction in taste receptors that respond to a sweet stimulus and compare this transcduction process to signal transduction in an olfactory receptor. An illustration of the steps involved in signal transduction of each of these stimuli will be helpful, however, you must also provide a written outline of the steps of signal transduction. (Worth 12 points).

In both cases the stimulant molecule binds to a protein receptor express on the cell membrane of the receptor and activates a G-protein on the inside of the receptor cell membrane, which in turn activates a second messenger system in the receptor. In the case of the sweet taste receptor the second messenger pathway results in the release of neurotransmitter onto a sensory afferent axon. Olfactory receptors are neurons, that have an axon that synapse on neurons in the olfactory bulb, there is no sensory afferent axon. In the case of the olfactory receptor the second messenger pathway leads to the generation of an action potential that is conducted along the axon. The ions involved in both the sweet taste receptor and olfactory receptor include Na^+ and Ca^{++}. In the olfactory receptor Cl^- ions are also involved. The details of signal transduction in these two types of receptors are provided below.

A sweet taste stimulus molecule (ex. Sucrose) activates a taste receptor by binding to a protein receptor expressed on the taste receptor cell apical membrane. This binding activates a G-protein called gustducin that initiates a second messenger pathway in the receptor cell. The second messenger pathway results in the conversion of PIP into IP3. The IP3 produced can lead to the release of neurotransmitter in two ways: 1) by triggering the release of intracellular calcium stores, 2) by triggering the opening of IP3 sensitive sodium channels in the receptor cell membrane. The opening of the sodium channels leads to depolarization and the opening of voltage gated calcium channels on the basal cell membrane. In either case, the increase in calcium concentration in the cytosol causes the release of neurotransmitter from the receptor on to the gustatory sensory afferent axon that innervates the taste receptor cell. In the case of a receptor that responds to a sweet stimulus, the neurotransmitter that is released is ATP.

The olfactory receptors express one or more receptor proteins that bind odorant molecules. The olfactory receptor protein is linked to a G-protein (G_{olf}) that is activated when an odorant binds to the receptor. The G-protein in turn activates adenylyl cyclase that is bound to the inside of the cell membrane. The adenylyl cyclase converts ATP to cAMP, which binds to and opens $Ca^{++/}Na^+$ channels in the cell membrane. The influx of Ca^{++} and Na^+ depolarizes the receptor, and the Ca^{++} also binds to and opens chloride channels on the receptor membrane. When the Cl^- channels open, Cl^- flows out. The outflow of negative charge reinforces the depolarization of the receptor membrane potential. This reinforcement of the depolarization makes olfactory receptors particularly sensitive to odorant molecules, and is the reason why some odors can be detected at very low concentrations. The depolarization of the receptor leads to the initiation of action potentials in the olfactory receptor axon.

28. Describe three functions of the cerebrospinal fluid (worth 6 points).

The cerebrospinal fluid (CSF) serves to:

1) **Provide bouyancy for the neural tissue of the brain and spinal cord. The brain and spinal cord float in the CSF which relieves any pressure on blood vessels supplying these neural tissues.**
2) **The CSF acts as a fluid padding around the CNS helping to protect it from banging and rubbing against the bone of the cranium and vertebral column.**
3) **The CSF provides a closely regulated fluid environment that is high in sodium and hydrogen ions and low in potassium ions.**

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29. Answer one of the following (A or B) (Worth 8 points). If you answer both questions completely correctly you will receive 4 extra credit points, no extra credit points will be given for partially correct answers. Circle the letter (A or B) of the question you want grades as your primary question. Unless your answer to the question you select as your primary question is completely correct you will not receive any points for your answer to the other question.

A) Starting with a taste bud on the anterior tip of the tongue describe the pathway by which gustatory sensation reaches the isocortex. Name all nerves and nuclei involved in this pathway as well as the part of the isocortex that processes gustatory sensation for the conscious sense of taste.

OR

B) Conscious perception of an odor requires that olfactory sensory input reach the isocortex. Starting with the cells of the olfactory bulb, describe the pathway by which olfactory sensation reaches the isocortex. Name all nuclei and the part of the isocortex involved in this pathway.

The taste buds on the anterior 2/3rd of the tongue are innervated by the facial nerve. The sensory afferent axons on the nerve that carry the gustatory information from these taste buds enter the brain as the facial sensory root and synapse on cells in the gustatory nucleus of the medulla oblongata. The cells of the gustatory nucleus send axons to synapse on the neurons of the ventral posterior medial nucleus (VPM) of the thalamus. The neurons of VPM send their axons through the internal capsule to synapse on neuron of the primary gustatory cortex.

The neurons of the olfactory bulb send their axons into the brain as the olfactory tract. Some of these axons synapse on neurons in the olfactory tubercle, which is a neural center that is situated near the point where the olfactory tract enters the brain. The neurons in the olfactory tubercle send their axons to synapse on cells in the medial dorsal (MD) nucleus of the thalamus. The cells in MD send their axons to the orbitofrontal cortex.

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Lab Practical Exam (each correct answer is worth 1 point). Enter your answers in the blanks below to the questions on the cards associated with the specimen.

1.___Dorsal column_____

2.___Superior colliculus _____

3.___Tegmentum_____

4.___Hypothalamus_____

5. ___Caudate_____

6.___Dorsal Root Ganglion_____

7.___Dorsal horn_____

8.___Corpus callosum_____

9.____Thalamus_____

10.____Pons_____