Exam 3 – Zoology 250

Instructor: John Godwin, Fall 2005

Name (please print): KEY

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This exam has 7 pages, Please check that your copy is complete.

Terminology/Short answer - These questions require terms or brief answers. (10 questions, 1 pt. each except where noted, 22 total pts)

1. You apply a toxin to a tissue that directly inhibits the production of cAMP. What enzyme does this toxin act on?
   Adenylyl cyclase

2. Imagine that when you apply a hormone to a cell you are studying, it produces an increase in intracellular calcium. The second messenger molecule responsible for this increase is likely ______ and the calcium is released from the ______. (2 pts)
   • IP3 (inositol triphosphate in the longer name and is also correct here)
   • Endoplasmic reticulum

3. Epinephrine stimulates glycogen breakdown in intact liver cells, but does not have this effect if the cells are homogenized (i.e., broken up). What explains this observation?
   Epinephrine (a.k.a. adrenaline) must act at a cell membrane receptor (being a protein-based hormone) and the membrane is destroyed in the example when the cell is broken apart (homogenized).

4. Snapping turtle embryos developing in a warm nest will become males while those developing in a cooler nest will become females. This is an example of ______. In contrast, mammals and birds exhibit ______. (2 pts)
   • Turtles (alligators and crocs, some fish, etc.): environmental sex determination
     (temperature-dependent sex determination is okay too)
   • Mammals and birds: genetic or genotypic sex determination

5. Briefly define what we mean by ‘endocrine disruption’
   • This is the interference of the function of the endocrine system by compounds from outside the animal or human (e.g., DDT and the estrogen receptor)
6. The diagram to the right here illustrates the system for stimulating the production and release of key hormones that regulate metabolic rate. For each of the lettered structures, indicate both the anatomical name of the structure or gland and the hormone produced (abbreviations are alright for the hormones). (1/2 pt each on the table below)

<table>
<thead>
<tr>
<th>Structure/Gland</th>
<th>Hormone</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. hypothalamus</td>
<td>TRH</td>
</tr>
<tr>
<td>B. Pituitary</td>
<td>TSH</td>
</tr>
<tr>
<td>C. Thyroid gland</td>
<td>Thyroid hormones (T3 &amp; T4 is fine too)</td>
</tr>
</tbody>
</table>

Finally on this question, what effect do the arrows ‘looping back’ up from the bottom structure indicate in terms of the function of structures/glands A and B? (1 pt, 4 pts total for this question).
- Negative feedback (could add negative regulation of hormone secretion in addition or instead here)

7. Referring to the diagram to the right here and using the spaces by each letter below, give the correct term for the structure indicated (1 pt each, 4 pts total).

A: cell body or soma (referring to the circled structure)
B: dendrite
C: axon (referring to the long cellular process rather than smaller cells here)
D: Synapse (credit also if you said synaptic terminal or synaptic cleft)
(referring to the connection between cells at this point)

8. What is the basic functional reason that the ‘giant axon’ of a squid is so large? (i.e., what purpose does having a large diameter axon serve?)
- Increases the speed of action potential conduction

9. Would you see saltatory conduction in the giant axon of a squid? (Yes/No, 1 pt) Why or why not? (1 pt, 2 pts total for this question)
- No
  - Squid (and other invertebrates) do not have myelinated axons
10. The figure to the right here shows effects of interactions with a neighboring neuron on membrane potential in a neuron from which recordings are being made. Answer the following questions with reference to this diagram. (1 pt each, 4 pts total)

- What is the term for the membrane effect labeled ‘A’?
  (abbreviating this is okay)
  Inhibitory Post Synaptic Potential (or IPSP)
  1/2 pt for ‘hyperpolarization’
- What is the term for the membrane effects labeled ‘B’?
  (abbreviating this is okay)
  Excitatory Post Synaptic Potential (or EPSP)
  1/2 pt for ‘depolarization’

- What is the term for the voltage indicated by the dashed line at –55 mV?
  Threshold (more correctly ‘threshold potential’)

- If you were to add high concentrations of K+ ions outside this neuron, would the resulting change be more similar to the change shown for ‘A’ or ‘B’ here?
  More like ‘B’

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**Multiple Choice Section**  (28 questions + 1 bonus, 1 pt each)

1. I am doing version __ of this exam:  A)  A,   B)  b

2. Frequently, very few molecules of a hormone are required to affect changes in a target cell. This is because
   a)  hormones are lipid-soluble and readily penetrate the membranes of the target cell.
   b)  hormones are large molecules that remain in circulation for months and can repeatedly stimulate the same cell.
   c)  the mechanism of hormonal action involves an enzyme cascade that amplifies the response to a hormone.
   d)  the mechanism of hormonal action involves the rapid replication of the hormone within the target cell.
   e)  the mechanism of hormonal action involves memory cells that have had prior contact with the hormone.

3. Only certain cells in the body are target cells for the steroid hormone aldosterone. Which of the following is the best explanation for why these are the only cells that respond to this hormone?
   a)  Only target cells are exposed to aldosterone.
   b)  Only target cells contain receptors for aldosterone.
   c)  Aldosterone is unable to enter nontarget cells.
   d)  Nontarget cells destroy aldosterone before it can produce its effect.
   e)  Nontarget cells convert aldosterone to a hormone to which they do respond.

4. Short blood vessels connect two capillary beds lying in which of the following?
   a)  hypothalamus and thalamus
   b)  anterior pituitary and posterior pituitary
   c)  posterior pituitary and thyroid gland
   d)  anterior pituitary and adrenal gland
   e)  hypothalamus and anterior pituitary

5. Hormone X produces its effect in its target cells via the cAMP second messenger system. Which of the following
will produce the greatest effect in the cell?
   a) a molecule of hormone X applied to the extracellular fluid surrounding the cell
   b) a molecule of hormone X injected into the cytoplasm of the cell
   c) a molecule of cAMP applied to the extracellular fluid surrounding the cell
   d) a molecule of cAMP injected into the cytoplasm of the cell

6. Which of the following statements about hormones is correct?
   a) Steroid and peptide hormones produce different effects but use the same biochemical mechanisms.
   b) Steroid and peptide hormones produce the same effects but differ in the mechanisms that produce the effects.
   c) Steroid hormones affect the synthesis of proteins, whereas peptide hormones affect the activity of proteins already present in the cell.
   d) Steroid hormones affect the activity of certain proteins within the cell, whereas peptide hormones directly affect the processing of mRNA.
   e) Steroid hormones affect the synthesis of proteins to be exported from the cell, whereas peptide hormones affect the synthesis of proteins that remain in the cell.

7. The primary reason steroid hormones usually act slowly is that
   a) target cells tend to ignore steroid hormones in favor of nonsteroid hormones.
   b) they are produced at very low concentrations.
   c) they are too large to enter a cell and therefore must first bind to a plasma membrane receptor before having an effect on a cell.
   d) acting via a signal transduction pathway makes for slower responses than does directly interacting with a cell's DNA.
   e) they turn genes on or off and it takes time for gene products to build up or become depleted.

8. Iodine is added to commercially-prepared table salt to help prevent deficiencies of this essential mineral. Which gland(s) require(s) iodine to function properly?
   a) parathyroids
   b) adrenal
   c) thyroid
   d) pancreas
   e) ovaries and testes

9. Oxytocin and ADH (a.k.a. vasopressin) are produced by the ________ and stored in the ________.
   a) hypothalamus; posterior pituitary
   b) anterior pituitary; kidneys
   c) anterior pituitary; thyroid
   d) adrenal cortex; adrenal medulla
   e) posterior pituitary; anterior pituitary

10. ________ are the main male hormones.
    a) Androgens
    b) Estrogens
    c) Mineralocorticoids
    d) Luteinizing hormones
    e) Progesterones

11. You would expect that blood samples taken from an individual who had been fasting for 24 hours would have
which of the following?
   a) high levels of insulin
   b) high levels of glucagon
   c) low levels of insulin
   d) low levels of glucagon
   e) both B and C

12. The sodium-potassium pump of neurons pumps
   a) $\text{Na}^+$ and $\text{K}^+$ into the cell.
   b) $\text{Na}^+$ and $\text{K}^+$ out of the cell.
   c) $\text{Na}^+$ into the cell and $\text{K}^+$ out of the cell.
   d) $\text{Na}^+$ out of the cell and $\text{K}^+$ into the cell.
   e) $\text{Na}^+$ and $\text{K}^+$ into the cell and $\text{H}^+$ out of the cell through an antiport.

13. Which of the following statements is false?
   a) All cells have a membrane potential.
   b) Gray matter is the site of neuronal integration.
   c) The outside of a cell is negative with respect to the inside of a cell.
   d) Squid axons are a model system for nerve conductance.

14. If the concentration of potassium in the cytoplasm of a nerve cell with a resting membrane potential of -70 mV
    were reduced below normal, the new resting potential would [THIS QUESTION BECAME A BONUS]
    a) still be -70 mV.
    b) be -69 mV or higher.
    c) be -71 mV or lower.
    d) be 0 mV.
    e) reverse polarity.

15. Repolarization of the membrane of a neuron after an action potential is a consequence of which of the following?
    I. calcium channels opening
    II. $\text{Na}^+$ channels inactivating
    III. $\text{K}^+$ channels opening
    A) I only
    B) II only
    C) III only
    D) I and II only
    E) II and III only
16. The membrane is at resting potential. (E)

17. Sodium gates close and potassium gates begin to open (B)

18. The membrane is unable to respond to any further stimulation, regardless of intensity. (D)

19. The voltage-gated sodium channels begin to open. (A)

20. Action potentials are normally carried in one direction from the axon hillock to the axon terminals. By using an electronic probe, you experimentally depolarize the middle of the axon to threshold. What do you expect?
   a) Two action potentials will be initiated, one going toward the axon terminal and one going back toward the hillock.
   b) No action potential will be initiated.
   c) An action potential will be initiated and proceed in the normal direction toward the axon terminal.
   d) An action potential will be initiated and proceed back toward the axon hillock.
   e) An action potential will be initiated, but it will die out before it reaches the axon terminal.

21. The divisions of the nervous system that have antagonistic actions, or opposing actions are
   a) motor and sensory.
   b) sympathetic and parasympathetic.
   c) presynaptic and postsynaptic.
   d) forebrain and hindbrain.
   e) central nervous system and peripheral nervous system.

22. Which of the following is a protein neurotransmitter (i.e., a neuropeptide) that functions as a natural analgesic (pain killer)?
   a) acetylcholine
   b) epinephrine
   c) endorphin
   d) serotonin

23. Which of the following is correct about the telencephalon region of the brain?
a) It develops as the neural tube differentiates.
b) It develops from the midbrain.
c) It is the brain region most like that of ancestral vertebrates.
d) **It gives rise to the cerebral cortex**
e) It divides further into the metencephalon and myelencephalon.

*For questions 24-26, choose the best answer from the following list. Each answer may be used once, more than once, or not at all.*

A. cerebrum  
B. cerebellum  
C. thalamus  
D. hypothalamus  
E. medulla oblongata

24. contains regulatory centers for the respiratory and circulatory systems **[E]**

25. Produces hormones that are secreted by the pituitary gland **[D]**

26. Coordinates muscle actions **[B]**

27. A stimulus has opened the voltage-gated sodium channels in an area of a neuron's plasma membrane. As a result, _______ rushes into the neuron and diffuses to adjacent areas; this in turn results in the _______ in the adjacent areas.

   a) sodium; opening of voltage-gated sodium channels  
   b) potassium; opening of voltage-gated potassium channels  
   c) sodium; opening of voltage-gated potassium channels  
   d) sodium; closing of voltage-gated sodium channels  
   e) potassium; opening of voltage-gated sodium channels

28. An impulse relayed along a myelinated axon "jumps" from _______ to _______.

   a) oligodendrocyte; Schwann cell  
   b) node of Ranvier; Schwann cell  
   c) **node of Ranvier; node of Ranvier**  
   d) Schwann cell; Schwann cell  
   e) Schwann cell; node of Ranvier

**Bonus**

29. Given the steps shown below, which of the following is the correct sequence for transmission at a chemical synapse?

   1. Neurotransmitter binds with receptors associated with the postsynaptic membrane.  
   2. Ca²⁺ ions rush into neuron's cytoplasm.  
   3. Action potential depolarizes the synaptic terminal membrane.  
   4. Ligand-gated ion channels open.  
   5. Synaptic vesicles release neurotransmitter into the synaptic cleft.

   a) 1, 2, 3, 4, 5  
   b) **3, 2, 5, 1, 4**  
   c) 2, 3, 5, 4, 1  
   d) 4, 3, 1, 2, 5  
   e) 5, 1, 2, 4, 3