Exam 3 - Zoology 250

Instructor: John Godwin, Fall 2004

Name (please print): _______ KEY _______

Sign your name ______________ in this space if you would like your grade to be posted by the last five digits of your student ID number (sign, do not put your ID#).

This exam has 6 pages, Please check that your copy is complete.

Terminology/Short answer - These questions require terms or brief answers. (16 questions + 1 bonus question, 1 pt. each except where noted, 27 pts total plus one bonus)

1. You have what you think is a new hormone purified from your study animal. Working with a cell-culture system, you can put calcium sensitive dyes into your study cells that will emit fluorescent light when intracellular calcium concentrations rise. When you add your new hormone to the cell culture, you indeed find that there is rise in intracellular calcium levels. Based on this information, answer the four questions below (1 pt each, 4 pts total).
   a. Is the receptor for this hormone likely to be in the target cell membrane or inside the cell (i.e., in the cytoplasm)?
      membrane
   b. What is the first enzyme activated after this hormone binds its receptor?
      Phospholipase C (half credit for Phospholipase alone)
   c. What is the specific second messenger molecule that hormone action alters the levels of in this case?
      Inositol triphosphate or IP₃ (same thing)
   d. Where does the Ca²⁺ come from when levels increase in the cytoplasm?
      The endoplasmic reticulum (‘ER’ is alright too)

2. Observation: epinephrine acts quickly to induce the breakdown of glycogen in intact liver and muscle tissues. However, it is ineffective if just placed in a test tube with glycogen and glycogen phosphorylase. Briefly, what explains these observations (what is now missing)?
   Epinephrine acts at the membrane by activating a second messenger system. In the absence of a membrane, there is no effect.

3. What makes a cell a ‘target cell’ for a particular hormone?
   - target cells have receptors for that hormone

4. The birth control pill contains the steroid hormones progesterone or a combination of progesterone and estrogen. What event does this hormonal treatment specifically block to prevent pregnancy? What general feature of hormonal regulation is this effect an example of? (2 pts total)
   Ovulation, negative feedback
5. You make a late night trip to Krispy Kreme and have a couple of ‘triple-glazed jumbo’ donuts. Blood levels of what hormone would be expected to rise in response to this? **Insulin**

6. What is the term for hormones whose target cells are other endocrine glands? **tropic**

7. At the time of metamorphosis, tadpoles undergo dramatic changes. What specific type of hormones are primarily responsible for inducing these changes? **Thyroid hormones (just ‘thyroid’, ‘thyroxine’, ‘T3’, or ‘T4’ would be alright here too)**

8. The basic developmental process by which an organism develops a body type we would call ‘male’ or ‘female’ is termed what? **Sexual differentiation**

9. What does the term ‘bioaccumulation’ mean? This means that compounds can accumulate in the tissues of an animal to higher levels than are found in their environment.

10. Identify the major parts of the neuron shown here by putting the appropriate letter in each box for the structure connected to that box. A – Dendrites, B – Axon, C – Synaptic Terminal, D – Cell body or Soma (1/2 pt each, 2 pts total)

11. Which basic division of the nervous system does ‘integration’ primarily take place in? **The central nervous system (CNS is okay here too)**

12. The membrane potential (also called the ‘Resting membrane potential’) depends primarily on what two features of the neuronal membrane? These ‘features’ can be the actions of specific proteins or characteristics of the membrane. (2 pts)
   i. Concentration gradients are created by the Na⁺/K⁺ pump [i.e., Na⁺ higher outside, K⁺ higher inside]
   ii. K⁺ leaks out [permeability is higher for K⁺, making the interior of the neuron negative relative to the outside]
13. List two things you would need to show to demonstrate that some new compound you have isolated is actually a neurotransmitter.

Several are possible here:
- Show that it is present at the synapse and released on stimulation
- Show that it causes a change (EPSP or IPSP) in the postsynaptic neuron (also okay: adding this to the synapse experimentally causes a change in the post-synaptic cell)
- Show that there is a mechanism to either destroy that compound in the synapse [e.g., acetylcholinesterase] or take it back up in the the presynaptic neuron [e.g., serotonin transporters]

14. Why is the action potential said to be ‘all-or-none’? What role does positive feedback play in this ‘all-or-none’ characteristic and how does this positive feedback work? (address the role of Na+ channels, 3 pts total here)
- Action potentials, once initiated continue to completion [i.e., no ‘half action potentials’ are seen]
- Positive feedback accounts for the ‘self sustaining’ nature of the rapid depolarization seen in the first part of the action potential.
- The voltage-gated Na⁺ channel responds to depolarization by opening, which increase depolarization, which opens more channels until all are open.

15. What two ways (adaptations) can the conduction speed in neurons be increased (1 pt each)? Which of these is not found in, say, earthworms or insects? (1 pt; 3 pts total)
- Increased axon diameter (‘size’ is okay here too)
- Myelination (insulation, Schwann cells, glial wrapping are okay here)
- Invertebrates don’t show myelination [this is a vertebrate-only characteristic]

16. You hear a noise late at night in another room of your house. Your pulse picks up in response, your breathing quickens and your pupils dilate. Which division of your autonomic nervous system is most active at this point?

Sympathetic

Bonus: When a mammalian embryo develops as a female, what set of embryonic ducts develops to form the reproductive organs?
Mullerian (needs to be exact here since this is a bonus question)

Multiple Choice (1 pt each, 23 points total)
1. I am writing version ___ of this exam.
   a) A, b) B

2. The hormone that increases blood glucose levels in humans is:
   a) Glucagon
   b) Insulin
c) Vasopressin
d) Adrenocorticotropic
   e) TSH
3. The enzyme that responsible for producing cAMP is:
   a) Phospholipase C
   b) **Adenylyl Cyclase**
   c) Protein Kinase C
   d) Lactase
   e) Glycerol Phosphorylase

4. You have a compound you suspect is a hormone, but you don’t know more. You introduce this compound into a cell culture and it alters the metabolic activity of these cells. Next, you add *anisomycin*, a protein synthesis inhibitor and find that this compound abolishes the activity of your suspected hormone. What type of hormone is it therefore likely to be?
   a) **Steroid**
   b) Protein
   c) Impossible to say from information provided.

5. When chemical messengers are released from non-neural cells and affect a target cell in their immediate vicinity, this is termed a ______ action:
   a) Paracrine
   b) Endocrine
   c) Neurotransmitter
   d) b and c are correct

6. What hormone is responsible for the release of milk in response to offspring suckling in a mammal? (hint: the same hormone plays a critical role during the birth process)
   a) **Oxytocin**
   b) Vasopressin
   c) GnRH
   d) TRH
   e) ACTH

7. The hormone described above is released from the:
   a) Anterior pituitary gland
   b) **Posterior pituitary gland**
   c) Left pinky toe

8. Which of the two divisions of the pituitary gland noted above has tropic hormones delivered to it by the hypothalamo-pituitary portal blood system?
   a) **Anterior pituitary gland**
   b) Posterior pituitary gland

9. Estrogen stimulates the production of the protein vitellogenin in many vertebrates. Which of the following descriptions best characterizes the way estrogen acts to have this action?
   a) The hormone diffuses through the membrane, binds a receptor and cause the release of Ca^{2+} from the endoplasmic reticulum.
   b) **The hormone diffuses through the membrane, binds a receptor, and then alters gene expression.**
   c) The hormone binds a receptor in the membrane and alters the activity of Adenyl cyclase
   d) The hormone binds a receptor in the membrane and alters the activity of Phospholipase C
10. Testosterone is produced and released by the testes and ovaries. It then travels through the bloodstream and binds to its receptor as:
   a) Testosterone
   b) Estrogen
   c) Dihydrotestosterone
   d) A-C can all be true

11. Gonadotropin-releasing hormone (GnRH) is produced in the:
   a) hypothalamus
   b) pituitary gland
   c) gonads
   d) liver
   e) right pinky toe

12. The sex of an animal is always determined by the chromosomes it receives at fertilization.
   a) This statement is true
   b) This statement is false

13. During mammalian development, male and female typical genital structures form from the same basic set of embryonic structures.
   a) This statement is true
   b) This statement is false

14. Can we just look at the chemical structure of a compound and conclude anything about its potential to interact with our endocrine system?
   a) Yes
   b) No

15. Most cells in your brain are neurons.
   a) This statement is true
   b) This statement is false

Questions 16-19 give the results of experimental manipulations on neuron function. For each one, pick from choices A-E below the most likely compound or manipulation to produce the effect on the neuron described and mark this letter choice on your scantron sheet.
   a) blockage of voltage-gated Ca^{2+} channels
   b) ouabain — blocks the Na^{+}/K^{+} pump
   c) blockage of voltage-gated K^{+} channels
   d) a decrease in K^{+} in the extracellular space
   e) tetrodotoxin — blocks voltage-gated Na^{+} channels

16. The neuron shows a steady depolarization regardless of whether an action potential takes place or not.
   Answer is B

17. The neuron shows a rapid depolarization after reaching the threshold potential, but does not show the rapid repolarization that usually immediately follows depolarization.
   Answer is C
18. The neuron transmits action potentials down the axon that are perfectly normal, but cannot release neurotransmitter.  
   **Answer is A**

19. The neuron can be depolarized, but does not show the very rapid depolarization characteristic of normal action potentials after the membrane reaches the threshold potential.  
   **Answer is E**

20. A response in a post-synaptic neuron that makes it less likely that that neuron will respond with an action potential is referred to as an:
   a) EPSP  
   b) ESP  
   c) **IPSP**  
   d) PCP  
   e) DDT

21. The refractory period after the action potential only goes in one direction down an axon because:
   a) The activation gate of the voltage-gated Na\(^+\) channel remains open long after the ‘spike’ portion of the action potential  
   b) The inactivation gate of the voltage-gated Na\(^+\) channel remains open long after the ‘spike’ portion of the action potential passes  
   c) The voltage-gated K\(^+\) channel stays closed beginning at the time the neuron reaches threshold potential  
   d) The Na\(^+\)/K\(^+\) pump remains inactive for a brief period after the action potential passes a given section of membrane  
   e) **None of the above answers is correct**

22. The hypothalamus is found in/part of the:
   a) Myelencephalon  
   b) Metencephalon  
   c) Mesencephalon  
   d) **Diencephalon**  
   e) Telencephalon

23. The part of the vertebrate brain ancestrally associated with vision (and still primarily associated with vision in non-mammals) is the:
   a) Forebrain  
   b) **Midbrain**  
   c) Hindbrain  
   d) Cerebellum  
   e) Parasympathetic nervous system