Exam 3
Zoology 250, Fall 2002

Please SIGN your name here if you would like me to post your grade by the last five digits of your social security number ______ KEY ________

Short Answer/Terminology (1 pt each except where noted, 31 pts total)

1. What is meant by negative feedback regulation of a hormonal system? (1 pt) Give a brief example that operates in a mammal (2 pts). You may use a diagram for the second part of the question if you wish. (3 pts total for this question)
- Negative feedback occurs when a change in a system feeds back to the control mechanism to reduce further changes in that direction.
- Lots of possibilities: e.g., GnRH causes release of LH/FSH which cause release of gonadal steroids. Gonadal steroids then act to reduce release of GnRH.

2. In the table below, check one box on each row to indicate whether the cellular response, experimental result described, or name of the hormone best fits under ‘steroid’ or ‘protein’ hormone (1 pt ea., 6 pts total)

<table>
<thead>
<tr>
<th>Characteristic, Action, or name</th>
<th>Protein</th>
<th>Steroid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: spelled 'protein'</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Pertussin toxin, a stimulator of G-protein function, mimics the hormone's action</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Actions are blocked by a toxin that impairs ribosome function</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Hormone is released into the hypothalamo-pituitary portal system</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Hormone can bioaccumulate in adipose tissue (i.e., fat cells)</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Hormone binding alters the activity of Phospholipase C</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Progesterone</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

3. In terms of the major parts of their structure, neurons receive information at the ________, send information out along the ________, and perform basic cell maintenance functions in the ________ (3 pts)
- dendrite(s), axon, soma (half credit for cell body)

4. If you were to count individual cells in your brain, what would be the most common type of cell? (use the general term for this type of cell here)
- glial cells (outnumber neurons by at least 3 to 1 in brain)

5. What is the key difference between excitable and non-excitable cells in your body? (answer by naming a class of proteins)
- the key difference is that excitable cells have voltage-gated channels
Questions 6 through 14 refer to the electrical recording from a single neuron over a few milliseconds shown below:

6. The membrane voltage difference the neuron is showing at point A (the state of the neuron at that point) is referred to specifically as the **resting membrane potential** (‘resting potential' is OK too).

7. If you characterized the movement of ions across the membrane at point A, which specific ion would you find was showing the greatest rate of diffusion across the neuron membrane and which direction would the net movement of this ion type be (i.e., would it be moving into or out of the neuron)? (2 pts total here)
   - potassium is showing greatest rate of diffusion, potassium is moving out of the neuron primarily

8. Which specific protein is critical for maintaining the neuron in the state shown at point A? (hint: this protein uses ATP).
   - the **Na\(^+\)/K\(^+\)** pump (Na\(^+\)/K\(^+\) ATPase is okay too)

9. Assume the neuron receives input from another neuron in the form of an Excitatory Post-Synaptic Potential (an EPSP) and indicate **on the X-axis** approximately where this stimulus is received (put an upwards pointing arrow (↑) at the appropriate place **on the X-axis on the figure above** to answer here).

10. The level of membrane voltage difference shown by the dashed line (the arrows from 'F' are pointing to it) is referred to **specifically** as the:
    - **threshold potential** (threshold is OK here too)
11. What is the important change in the neuron in activity/permeability of membrane ion channels as the membrane voltage difference approaches and crosses the dashed line? (1 pt) What very specific structure accounts for this change in ion channel permeability? (1 pt, 2 pts total for question 11)
- the permeability to Na\(^+\) is increasing enormously. This increase in permeability is due to the opening of the activation gate of the Na\(^+\) channel.

12. Why specifically does the rapid upwards sweep in membrane voltage difference shown at point C reflect positive feedback? (2 pts)
- the increase in membrane potential causes the activation gates of the voltage-gated Na\(^+\) channel to open which further increases membrane potential which further opens these gates ...(and so on)

13. Three things/changes we talked about act to limit the upwards sweep of the membrane voltage difference (shown at point 'D' in the diagram). List two of these three that are occurring around point 'D' on the figure (2 pts).
- the voltage-gated Na\(^+\) channel inactivation gate closes
- the voltage-gated K\(^+\) channel opens
- the concentration gradient for Na\(^+\) from outside to in is being lost as Na\(^+\) increases greatly inside the neuron

14. If you characterized the movement of ions across the membrane at point E, i) which specific ion would you find was showing the greatest movement across the neuron membrane, ii) which direction would this ion be moving in (i.e., would it be moving into or out of the neuron), and iii) which specific protein is primarily responsible for allowing movement of this ion at point E? (3 pts)
- K\(^+\) is showing greatest movement across the membrane
- K\(^+\) is moving out of the neuron
- the voltage-gated K\(^+\) channel allows this movement when it opens around the peak of the A.P.

15. You have isolated a compound from the brain of your study organism and hypothesize that it represents a new neurotransmitter. List two things (of three possible that we discussed) that you would need to demonstrate to convince other neuroscientists that you had indeed discovered a new neurotransmitter (2 pts total for this question).
- presynaptic cells must contain the compound and release it on stimulation
- the compound must cause either an EPSP or and IPSP in the post-synaptic cell
- the compound must be either degraded in the synapse (e.g., acetylcholinesterase) or taken back up by the presynaptic neuron (e.g., dopamine or serotonin transporter reuptake mechanisms)
Multiple Choice Questions (1 pt each)

1. I am writing Exam Version _____
   a) A  
   b) B  

2. Which of the following is not a tropic hormone?
   a) Gonadotropin releasing hormone  
   b) Thyroid stimulating hormone  
   c) progesterone  
   d) Corticotropin releasing hormone  
   e) B and D  

3. In your body, ______ reduces blood levels of glucose while ________ acts to increase blood levels of glucose.
   a) insulin, glucagon  
   b) glucagon, insulin  
   c) insulin, GnRH  
   d) glucagon, vasopressin  
   e) none of the above  

4. Identifying endocrine disrupting compounds is relatively straightforward because they show strong chemical similarities to natural estrogens and androgens.
   a) This statement is true  
   b) This statement is false  

5. In a condition termed androgen-insensitivity syndrome, individuals have an XY genotype, but have a female external phenotype. This condition results from a faulty copy of the androgen receptor gene. This real-life medical example illustrates what basic feature of mammalian sexual development?
   a) External sexual phenotype development is controlled entirely by which sex chromosomes an individual inherits at fertilization.  
   b) External sexual phenotype development in mammals can be characterized mainly as active feminization of an essentially 'default' male phenotype.  
   c) **External sexual phenotype development in mammals can be characterized mainly as active masculinization of an essentially 'default' female phenotype.**  
   d) External sexual phenotype development is controlled by the external environment.
6. Sex is determined at fertilization in all animals by the chromosomal contributions of the mother and father.
   a) This statement is true
   b) This statement is false

7. The basic model for how the nervous system works is input, integration, output. At the level of the system the input is the
   a) motor neuron
   b) sensory neuron
   c) interneuron
   d) skeletal muscle

8. What accounts for the white part of the spinal cord appearing white (that is, if we removed this part the tissue would no longer appear white) ?
   a) the lack of blood to these cells
   b) the axon
   c) the cell bodies
   d) myelination

9. You would find 'white matter' in the central nervous system of a crayfish similar to that found in your spinal cord.
   a) This statement is true
   b) This statement is false

10. A neurotransmitter that changed the voltage difference across the membrane in a post-synaptic cell from -70 mV to -60 mV would be said to be ___________ and likely act by opening ___________ channels
    a) hyperpolarizing, potassium
    b) hyperpolarizing, sodium
    c) depolarizing, chloride
    d) depolarizing, potassium
    e) depolarizing, sodium

11. The part of a neuron that has neurotransmitter-gated channels (channels that are opened in response to neurotransmitter binding) on it.
    a) Schwann cell
    b) dendrites
    c) axon
    d) synaptic knob (end of the axon)
12. Which of the following are responsible (i.e., critical) for generating an action potential.
   a) neurotransmitter-gated channels
   b) voltage-gated Calcium channel
   c) Schwann cell
   d) **voltage-gated sodium channel**
   e) A and C are correct

13. Administration of a large amount of potassium to a person can be life threatening. At the level of individual neurons, what would you predict the effect of raising the concentration of potassium in the extracellular space would be (i.e., increasing potassium outside the neuron)?
   a) hyperpolarization
   b) **depolarization**
   c) no change

14. The basic brain division considered the 'seat of intelligence' in humans:
   a) myelencephalon
   b) metencephalon
   c) mesencephalon
   d) diencephalon
   e) **telencephalon**

15. Thanksgiving comes up in a couple of weeks and most people will sit down for a big meal that will induce a very calm, almost sleepy state afterwards. Under these conditions, the ________ division of the ________ nervous system is the major influence on basic bodily functions.
   a) parasympathetic, autonomic
   b) sympathetic, autonomic
   c) sympathetic, vestibular
   d) parasympathetic, vestibular
   e) sympathetic, central

**Bonus:** What special embryonic cell type most contributes to increasing action potential conduction speed in your nervous system? (1 pt)

**Neural Crest cells (progenitors to lots of things, including oligodendrocytes and Schwann cells)**