Part I. Multiple Choice. 2 Points Each (32 Points Total).

1. Which ONE of the following is FALSE regarding graded potentials?
   A. They die out quickly
   B. They are long-distance signals
   C. They can be generated by a triggering event
   D. They can be generated by a physical stimulus

2. Following an action potential, the ____________ sets a limit on how soon another action potential can begin. It also prevents action potentials from going in both directions along an axon.
   A. graded potential
   B. Na+/K+ ATPase pump
   C. refractory period
   D. triggering event

3. Which ONE of the following is FALSE regarding myelinated axons?
   A. Myelinated axons conduct action potentials faster than unmyelinated axons
   B. Multiple sclerosis is a demyelinating disorder
   C. PNS myelin is formed by Schwann cells
   D. Impulses jump from internode to internode

4. Which ONE of the following is FALSE regarding ionotropic receptors?
   A. Neurotransmitter binding causes a fast postsynaptic response
   B. The receptor is also an ion channel
   C. Neurotransmitter binding activates a second messenger cascade
   D. They are more likely to be activated by neurotransmitters than by neuropeptides

5. Major homeostatic regulatory centers in the central nervous system (regulate heart rate, breathing, hunger, thirst, etc.) are located in
   A. hypothalamus
   B. cerebellum
   C. brainstem
   D. both A and B
6. Which ONE of the following is NOT a function of astrocytes?

A regulate ionic composition of extracellular fluid in the brain
B help neurons take up neurotransmitters at the synapse
C formation of myelin
D formation of glial scars following injury

7. Which ONE of the following is FALSE regarding the blood-brain barrier (BBB)?

A Alcohol (ethanol) cannot cross
B There are specific transport proteins for amino acids and glucose
C Gases ($O_2$ and $CO_2$) pass freely across the BBB
D Tight junctions between cells forming brain capillaries are important for barrier function

8. Which ONE of the following is NOT a touch receptor?

A Merkel disk
B Meissner’s corpuscle
C Pacinian corpuscle
D Capsaicin receptor

9. Which of these pain-sensing neurons responds the slowest (= “second pain’)?

A Polymodal
B Thermal
C Mechanical
D Both Band C

10. Which ONE of the following is most likely to benefit from radial keratotomy?

A A presbyopic person
B A hyperopic person
C An emmetropic person
D A myopic person

11. Which ONE of the following is FALSE regarding taste receptor cells?

A Sourness is detected when $H^+$ block $K^+$ channels, depolarizing the taste cell
B Sweetness is detected when “sweet molecules” open CI- channels, depolarizing the taste cell
C Umami is a taste that is stimulated by MSG (monosodium glutamate)
D Taste receptor cells are not neurons
12. Which ONE of the following is FALSE regarding olfaction?

A  Each olfactory neuron is specialized to detect a single type of odorant  
B  Olfactory neurons cannot regenerate  
C  The sense of smell follows two pathways in the brain: one a conscious perception pathway, the other a subconscious pathway to the limbic system  
D  The olfactory bulb contains mitral cells that may sort/combine the odor sense

13. Which ONE of the following is FALSE regarding hair cells involved in hearing?

A  They are supported by the tectorial membrane, which vibrates in response to sound  
B  Stereocilia are embedded in the tectorial membrane, and bend against it  
C  Positive ions enter through open ion channels when stereocilia are bent  
D  Hair cells depolarize/repolarize in a manner that matches the frequency of the sound being sensed

14. Which ONE of the following is TRUE regarding photoreceptor physiology

A  Photoreceptors are hyperpolarized in the dark  
B  Opsin, bound to a chromophore (retinal) is the light-sensitive protein that pops out of the retina when light is sensed  
C  In the dark, Na+ channels in the outer segment are closed  
D  Photoreceptors release more glutamate in the dark

15. Which ONE of the following is FALSE regarding the efferent branch of the PNS?

A  Only three neurotransmitters are used: acetylcholine, norepinephrine, and dopamine  
B  Parasympathetic preganglionic neurons originate in the “head and butt” regions of the spinal cord and used acetylcholine as the neurotransmitter  
C  Sympathetic postganglionic neurons use norepinephrine as the neurotransmitter  
D  Effector organs usually have some combination of muscarinic acetylcholine receptors and some type of NE receptor

16. Which ONE of the following is FALSE regarding the endocrine system?

A  Endocrine organs are not attached to each other but have coordinated activities.  
B  The endocrine system regulates homeostasis more slowly than the nervous system but can result in larger and more long-lasting changes.  
C  The activity of a hormone on a target tissue depends on whether that target tissue has receptors for the hormone.  
D  A single hormone has just one type of target tissue.
Part II. Short Answer (and some other odds and ends). 3 Points Each (or as indicated; 56 Points Total).

17. (6 Points) Match the events in the action potential with the mechanism for each event (fill in the letter at the appropriate place in the diagram).

A. Voltage-gated Na+ channels open, Na+ flows in along its electrical and chemical gradients, causing more Na+ channels to open; positive feedback loop established.
B. Voltage-gated Na+ channels shut down, more K+ channels open, K+ rushes out along its electrical and chemical gradients.
C. Most Na+ channels closed; many K+ channels open.
D. K+ carries out too many + charges.
E. At threshold, “all” Na+ channels open, Na+ rushes out.
F. Triggering event depolarizes membrane.

18. (8 Points) Fill in the missing steps in the description of synaptic transmission.

1. Action potential arrives at synaptic terminal.
2. ________________
3. ________________
4. Neurotransmitter diffuses across synaptic cleft and binds to a receptor.
5. ________________
6. ________________
19. Name 1 way a drug might affect synaptic transmission. ____________________________

20. True or False. When several EPSPs at one synapse occur at such a high frequency that they may add up to threshold it is called spatial summation. __________

21. The NMDA receptor is a glutamate receptor that is involved in learning and memory. Two things need to happen in order for this receptor/ion channel to operate (allow Na+ and Ca++ into the postsynaptic neuron). What are they? _______________ and _______________

22. A retrograde messenger that may be important in long-term-potentiation (synapse strengthening; memory and learning) is ____________________________ (please spell it out).

23. What three things contribute to our sense of body position/posture/balance?

24. The type of neuron that “resets” the stretch receptor during voluntary movement is called ____________________________

25. What are the 4 “F”s (please use the politically correct term for the 4” “F"-- I don’t want to get in trouble O)? ____________________________

26. These (the 4 “F”s) are regulated by which branch of the efferent PNS?

27. Estradiol is a steroid hormone derived from cholesterol.
   A How is estradiol transported in the blood? (dissolved in plasma or bound to protein) _______________
   B Does estradiol bind to cell surface receptors or receptors in the cell nucleus?

28. Name 2 symptoms of hypothyroidism. ____________________________

29. What is the major hormone of the “stress response”? ______________

30. What are the major hormones/neurotransmitters of the “fight or flight” response? (please spell out for full credit)? ____________________________
31. The diagram shows regulatory pathways for cortisol release.

![Diagram of cortisol release pathway]

Which hormones are the tropic hormones?

Which hormone is the non-tropic hormone?

32. Complete the diagram by indicating which hormones regulate the release of other hormones in the pathway by a negative feedback interaction (draw an arrow).

33. Part III. Describe and/or Illustrate. Points as indicated (22 Points Total).

33. 6 Points. Choose ONE of the following. Please indicate your choice.

A Lateral inhibition allows a stimulus to be precisely localized. Please draw a diagram that shows how lateral inhibition works.

B Draw the stretch reflex (knee jerk reflex), include (and label) the following:
  - stretch receptor
  - muscle
  - sensory afferent
  - spinal cord
  - alpha motor neuron
34. 8 Points. Choose ONE of the following. Please indicate your choice.

A Describe endogenous analgesia as we discussed in class; include in your answer the action of enkephalin, and please illustrate your answer!
B Describe the "dopamine hypothesis" of drug addiction. Include in your answer the neuronal pathways involved and some evidence for this hypothesis.

35. 8 Points. Choose ONE of the following. Please indicate your choice.

A Describe how a hair cell converts a physical stimulus into neurotransmitter release. Please include an illustration.
B Describe how a photoreceptor converts a physical stimulus into a change in neurotransmitter release. Please include an illustration.

Extra Credit (3 points): Briefly explain how cold water in the ear can be used to assess brainstem integrity in a comatose patient.