1. An axon in a spinal nerve:
   a. may arise from a soma in a dorsal root ganglion
   b. may arise from a soma in the cerebral cortex
   c. may arise from a soma in the spinal cord
   d. is never unmyelinated
   e. may have one end in the skin, and another in the brainstem

2. The ability to discriminate stimuli at two closely spaced points on the skin:
   a. is best where type C (group IV) afferents have the smallest cutaneous receptive fields
   b. is degraded by lesions of the ipsilateral dorsal column
   c. is better on the tongue than on the forehead
   d. depends critically on an intact anterofateral system
   e. depends critically on neural processing in the precentral gyrus

3. Inhibitory synapses in the central nervous system
   a. often use an amino acid as their neurotransmitter
   b. may be weakened by clinically useful drugs that cause sedation
   c. are important in the spinal cord and the brainstem, but not in structures rostral to them
   d. always use a single subtype of neurotransmitter receptor (GABA) or G protein-coupled receptors
   e. may use either ligand-gated receptors, or G protein-coupled receptors

4. The characteristic or 'best' frequency of an auditory hair cell
   a. is that frequency at which its threshold is highest
   b. increases as the intensity of sound increases
   c. may be as low as 10 Hertz in humans
   d. depends on its position along the basilar membrane
   e. changes when there is more activity from the olivocochlear bundle

5. Outer hair cells
   a. outnumber inner hair cells
   b. change their length in response to changes in their membrane potential
   c. have many more auditory nerve fibers innervating them than inner hair cells do
   d. are contacted by both endolymph and perilymph
   e. are necessary for generating otoacoustic emissions

6. Left homonymous hemianopia
   a. could be caused by a lesion of the right lateral geniculate nucleus
   b. could be caused by a lesion to the left optic nerve
   c. may be accompanied by macular sparing
   d. is unlikely to result from a pituitary tumor
7. The "near response" to an approaching object is composed of:
   miosis
   divergence of the visual axes
   flattening of the lens
   relaxation of the ciliary muscle
   increased activity in cranial nerve III

8. Features that contribute to the high spatial acuity of foveal vision include:
   smaller retinal blood vessels in front of the central fovea
   more photoreceptors relative to optic nerve axons, compared to the parafovea
   increased thickness of the retina in the foveal area due to the high concentration of ganglion cells
   the fact that the fovea is less sensitive to light than the parafovea
   the high density of cone photoreceptors in the fovea

9. Vertebrate photoreceptors
   a. increase their production of cAMP in response to light
   b. exhibit different spectral sensitivities when the opsin components of their photopigments differ
   c. employ a form of Vitamin D₃ as the chromophore of their photopigments
   d. shed the membranous disks of their outer segments into the pigment epithelium
   e. become anoxic if there is retinal detachment

10. Which of the following are true of a myope?
    a. the eye's optics form the image of a very distant object in front of the retina
    b. when the myopic subject views a distant object, the ciliary muscle must contract more strongly than it does for a hyperope (hypermetropia).
    c. looking through a pinhole can improve the clarity of distant objects
    d. near objects are seen less clearly than distant objects
    e. vision can be corrected with convex lenses

11. A burn on the skin of the hand
    a. activates the nerve endings of C fibers
    b. can induce secondary hyperalgesia mediated by neural changes in the central nervous system
    c. would be exacerbated by bradykinin injected into the affected area of skin
    d. triggers action potentials that propagate both orthodromically and antidromically in sensory axons of the skin
    e. increases the rate of release of substance P in the ipsilateral segments of the spinal cord.

12. The taste system
    a. involves nearly 1000 different taste receptor proteins, each expressed by a different set of taste receptor cells
    b. involves taste receptor cells that are specifically sensitive to either salty, sweet, sour, bitter, or amino acid (umami) substances
    c. can involve sensory information carried by cranial nerves I, V, VII, IX, and X
    d. has axonal pathways that project directly to gustatory cortex without relaying in the thalamus
    e. has efferent axons arising from the nucleus of the solitary tract that modulate taste receptor cell function

13. The dorsal horn of the spinal cord is a site where:
    a. myelinated and unmyelinated afferent fibers converge and synapse on certain interneurons
    b. visceral and cutaneous fibers may converge and synapse on neurons mediating nociception
    c. opiates can induce analgesia.
    d. second order axons of the dorsal column/medial lemniscal system arise
    e. nociceptive activity can be modulated by descending projections from the brainstem
14. Perception of the type and intensity of a sensory stimulus is influenced by
   a. the amplitude of action potentials in the responding fibers
   b. the amplitude of the receptor potential
   c. the firing rate of the affected peripheral axons
   d. which particular central sensory pathway carries the information
   e. the number of fibers activated by the stimulus

15. When the dark-adapted human eye is exposed to steady, bright light
   a. visual spatial acuity decreases
   b. miosis occurs
   c. retinal sensitivity to light decreases
   d. the retina becomes more sensitive to blue than to red light
   e. the retina switches from being achromatic to trichromatic

16. The trigeminal equivalent of
   a. Lissauer's tract is the spinal tract of V
   b. a dorsal root ganglion is the main sensory nucleus of V
   c. a C- or Group IV fiber is a Group V fiber
   d. the VPL nucleus of the thalamus is the VPM nucleus of the thalamus.
   e. the substantia gelatinosa is the spinal nucleus of V

II. Place the number or name of the cranial nerve whose dysfunction would produce the clinical finding. Indicate which side is affected. (10 points)

   [o.d.-right eye, o.s.-left eye, o.u.-both eyes]

<table>
<thead>
<tr>
<th>Side</th>
<th>Nerve</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R+</td>
<td>V</td>
<td>Hyperacusis in right ear (two possibilities, either will do)</td>
</tr>
<tr>
<td>R+</td>
<td>III</td>
<td>Ptosis and mydriasis, o.d.</td>
</tr>
<tr>
<td>L+</td>
<td>III</td>
<td>Illuminate either eye, pupil of o.d. but not o.s. constricts</td>
</tr>
<tr>
<td>L+</td>
<td>II</td>
<td>Neither pupil constricts when o.s. illuminated, both pupils constrict when o.d. illuminated.</td>
</tr>
<tr>
<td>L+</td>
<td>V</td>
<td>Touch left cornea, neither eye blinks; touch right cornea, both eyes blink</td>
</tr>
</tbody>
</table>
III. Short answers. In the space provided, briefly answer the following questions:

1. If cranial nerve V on the right is damaged, what would be the effects of touching the right cornea, and why? (2 points)
   When the right cornea is touched neither eye will blink because the synapse with VII on both sides will not be made.
   The left cornea? Why? (2 points)
   When the left cornea is touched synapses will be made on VII for both eyes - so both eyes will blink.

2. Name (list) four kinds of neural information that the central nervous system employs to allow you to identify an object such as a car key that is at the bottom of your pocket. (4 points)
   Touch (haptics) - via the DMSL system → sensory cortex
   Temperature - via the AL system
   Pain (jagged edges) → sensory cortex
   Auditory (to hear the particular jangle in your pocket) → auditory cortex
   Memory of keys → perception of key

3. What is hemineglect syndrome, and what sort of brain damage causes it? (2 points)
   Hemineglect syndrome occurs when there is damage to the parietal cortex, particularly on the right side. It causes the person to neglect/ignore one side of the world including the side of the person’s body.

4. List five (apparently true, to the best of your knowledge) things about the neurons of the olfactory system that you learned this semester. (5 points)
   - There are more than 900 different receptor proteins encoded for by the human genome.
   - Olfactory neurons, the primary ones, are the only neurons that regenerate.
   - An incredibly complex path-making system allows all of the neurons of a particular receptor type to synapse on the same glomerulus in the olfactory bulb.
   - Like the optic nerve, the olfactory nerve is an extension of the brain rather than a true cranial nerve.
   - The second order neurons do not "relay" in the thalamus, some go directly to the "rhinencephalon" which include the olfactory tubercle, pyriform cortex, and the amygdala - explaining the very emotional and memory-laden experience of smell.
IV. Next to the letter in the following list, write the name of the structure indicated in the figure (15 points)

A. Corpus Callosum  
B. Head of caudate  
C. Internal Capsule  
D. Putamen  
E. Claustrum  
F. Thalamus  
G. Tail of caudate  
H. Cerebellum  
I. Occipital lobe  
J. Lateral ventricle  
K. Pons  
L. 3rd ventricle  
M. Insula  
N. Fornix  
O. Lateral ventricle