Exam 1

Name ____________________________

Purdue ID ____________________________

Your score on this exam will count toward 17% of your final grade.
The following short answer questions are worth 10 points each. All answers should be legible and in complete sentences and may include figures or diagrams. You might lose points for extremely bad handwriting, grammar, or syntax.

(A) Describe a situation where a patient with a cut corpus callosum would demonstrate unusual behavior.

Have the patient sit in from an opaque screen and stare at a central fixation point. Present a word to the left of the fixation point. The visual information about the word travels to the right hemisphere of the patient. If you now verbally ask the patient what was the word, he will respond that he does not know. This answer is because the patient’s speech is controlled by the left hemisphere, and the left hemisphere does not know what word was presented (only the right hemisphere knows that information). If you now ask the patient to place his left arm under the screen and select an object that corresponds to the word, the subject can do this task (because the right hemisphere knows the word and controls the left arm). Thus, the subject both knows the word (right hemisphere) and does not know the word (left hemisphere).
(B) Explain how a difference map is created for a brain scan, and explain why the difference map is needed to relate brain areas to cognitive behavior.

A difference map comes from two separate brain scans, a control and an experimental scan. Each scan records the BOLD signal (for fMRI) during the task for each position (voxel) in the brain. The difference map is then simply the difference of the BOLD signal at each location. Those places in the brain that are involved in both the control and experimental scans (e.g., breathing, seeing the walls of the room) should have similar BOLD signals, so their difference should be close to zero. The difference map is needed for precisely that reason, to zero out those common signals. Those brain places with big differences indicate areas that are involved in the task of the experimental scan but were not involved in the control scan.

(C) Explain how the receptive field of a “simple cell” is built up from center-surround cells.

Each simple cell receives input from a set of center-surround cells that have receptive fields whose center run in a particular spatial orientation on the retina. Thus, the simple cell receptive field will correspond to a pattern of light that covers the excitatory center of many center-surround cells (e.g., a bar of light in the correct orientation). The simple cell will be inhibited by signals that are in the wrong position (e.g., in the inhibitory parts of the center-surround cells) and will respond poorly if the bar is of the wrong orientation. The graph below schematizes some center-surround cell receptive fields (left) and how their sum would correspond to a simple cell receptive field.
(D) Explain how the “resonance hypothesis” is related to a network of neuron activities “settling down.”

The resonance hypothesis is that cognitive states (e.g., having a memory, making a decision, moving a limb, having an emotion) correspond to a stable pattern of activity across a network of neurons. The property of a network of neurons settling down is exactly what is meant by a resonant state. In the resonant state, neurons that excite each other (at least as a group) keep each other active, while they (again, as a group) inhibit other neurons in the network. It may take some time to excite neurons that were not initially active and to inhibit neurons that were initially active but are inconsistent with other neurons being active. That is the settling down process.

The following multiple choice questions are worth 2 points each. Enter your answer on the scantron sheet. Enter only one choice for each question.

(1) Which of the following is an example of **contralateral processing**?
   (a) the left hemisphere controls the right arm.
   (b) the left hemisphere controls the left leg.
   (c) the fore-brain controls the back muscles.
   (d) the hind-brain controls the facial muscles.

(2) Which of the following statements is true?:
   (a) the left hemisphere deals with language, while right hemisphere does not.
   (b) both the left and right hemispheres are equally involved in language.
   (c) the right hemisphere is more involved with language than the left hemisphere.
   (d) the left hemisphere is more involved with language than the right hemisphere.

(3) The primary sensory area is part of which brain lobe?:
   (a) occipital.
   (b) temporal.
   (c) parietal.
   (d) frontal.
(4) Which brain lobe tends to be involved in visual perception?:
   (a) occipital.
   (b) temporal.
   (c) parietal.
   (d) frontal.

(5) Which brain scan technique has the best temporal resolution?:
   (a) EEG.
   (b) MRI.
   (c) fMRI.
   (d) diffusion spectral imaging.

(6) An EEG device measures:
   (a) the BOLD signal.
   (b) electrical signals on the scalp.
   (c) action potentials.
   (d) brain activity.

(7) The colors corresponding to “brain activity” in an fMRI scan typically correspond to:
   (a) action potentials.
   (b) BOLD signals.
   (c) differences in BOLD signals across a control and experimental condition.
   (d) places where the BOLD signal is the same for both a control and experimental condition.

(8) Which of the following is not a misconception about brain scan techniques?:
   (a) they demonstrate that cognition happens in the brain.
   (b) they prove a physiological basis for cognition.
   (c) they identify places in the brain involved in a cognitive task.
   (d) they show how the brain performs a cognitive task.

(9) The main difference between an MRI scan and an fMRI scan is:
   (a) the spatial resolution.
   (b) they use different types of machines.
   (c) the temporal resolution.
   (d) the analysis of the data.

(10) The tongue display unit discussed in class allowed a blind person to “see” with their tongue. A brain scan of a person using the unit:
    (a) suggested that this type of “seeing” uses the brain areas that non-blind people use for vision.
    (b) was ineffective because it lacked temporal resolution.
    (c) did not reveal anything that we did not already know.
    (d) suggested that this type of “seeing” uses the brain areas involved in touch and motor control of the tongue.
(11) Which of the following is a fundamental limitation of the “mind reading” from fMRI scans that we discussed in class?:
(a) it only gets 71% correct.
(b) it performs just as well for identifying the subject’s response as for the subject’s mental intention.
(c) it can only identify the cognitive states it was specifically designed to handle.
(d) it does not work if the corpus callosum is cut.

(12) The “input” to a neuron uses which anatomical part?:
(a) axon.
(b) dendrites.
(c) myelin sheath.
(d) soma.

(13) At rest, the electrical difference between the inside of a neuron and the outside of a neuron is?:
(a) 10 mVolts.
(b) -70 mVolts.
(c) 20 mVolts
(d) 0 mVolts.

(14) The rising electrical potential during an action potential corresponds to the flow of:
(a) sodium into the cell membrane.
(b) potassium out of the cell membrane.
(c) neurotransmitter into the cell membrane.
(d) neurotransmitter out of the cell membrane.

(15) The arrival of an action potential at a synapse causes:
(a) neurotransmitter to be released into the synaptic cleft.
(b) receptors to grab neurotransmitter.
(c) receptors to release neurotransmitter
(d) the action potential to be converted into a purely electrical signal that “jumps” across the synaptic cleft.

(16) Patients with Tourette’s syndrome have a condition whereby the brain:
(a) produces too much dopamine.
(b) produces too little dopamine.
(c) inefficiently uses its dopamine.
(d) only uses dopamine for inhibitory effects.

(17) The drug curare is a poison because it:
(a) resembles endorphin peptides.
(b) mimics serotonin.
(c) blocks acetylcholine.
(d) enhances the effects of dopamine.

(18) Which best describes the term receptive field?:
(a) the stimuli that increase a neuron’s firing rate.
(b) the stimuli that decrease a neuron’s firing rate.
(c) the stimuli that change a neuron’s firing rate.
(d) the stimuli that do not influence a neuron’s firing rate.
(19) What kind of stimulus would produce the strongest firing rate for a neuron with an on-center, off-surround receptive field?:
(a) a small spot of light.
(b) a spot of light that fills the on-center.
(c) a line of the correct orientation.
(d) a moving line.

(20) What kind of stimulus would produce the strongest firing rate for a neuron with a simple receptive field?:
(a) a small spot of light.
(b) a line of the correct orientation.
(c) a line of the correct orientation and position.
(d) a moving line.

(21) The neurons that directly feed into the complex cells have what kind of receptive field?:
(a) one-center, off-surround.
(b) wavelength-sensitivity.
(c) simple
(d) hypercomplex.

(22) We argued against the idea that a single neuron responds to your grandmother’s face because:
(a) a single action potential does not do much by itself.
(b) the necessary receptive field cannot be learned.
(c) there are not enough neurons for this kind of approach.
(d) this approach would only work if there were no inhibitory neurons.

(23) The perception of “illusory contours” is most closely related to a network:
(a) with activities that settle down.
(b) having error correction capabilities.
(c) tolerating the loss of some cells.
(d) using Hebb’s rule.

(24) In the neural network demonstration we discussed in class, each letter corresponded to a model:
(a) synapse.
(b) neuron.
(c) action potential.
(d) cognitive state.

(25) In the neural network demonstration we discussed in class, a model neuron receives 3 excitatory and 2 inhibitory inputs. What will happen to the neuron?:
(a) it will not change.
(b) it will become active.
(c) it will become inactive.
(d) it changes its connection strength.
(26) The neural network we demonstrated in class does not have a “master” or “controller” neuron that is necessary for the network to function. This characteristic is related to:
(a) network activities “settle down.”
(b) the network has “error correction capabilities”
(c) the network can “tolerate the loss of some cells.”
(d) the network uses feedback.

(27) In the neural network that we demonstrated in class, the model term connection weight corresponds to a:
(a) synapse.
(b) neuron.
(c) action potential.
(d) cognitive state.

(28) If two neurons are active at the same time, Hebb’s rule says that they:
(a) adjust so that in the future they fire at different times.
(b) develop an excitatory connection.
(c) develop an inhibitory connection.
(d) will always be active together in the future.

(29) In the neural network demonstration we discussed in class, learning involves changes in:
(a) synapses.
(b) neurons.
(c) action potentials.
(d) cognitive states.

(30) The brain of an infant watching their hand move is probably applying:
(a) Hebb’s rule to learn eye-hand coordination.
(b) grandmother cells to grasp objects.
(c) receptive fields to detect motion.
(d) the resonance hypothesis to create action potentials.