1. **Give three functional reasons why we have so many parallel processing pathways in the visual system.**

One reason is that in the real world, lots of different qualities are processed in the visual system, such as color, shape, motion; it is useful to have parallel processing so that people can extract particular information they are looking for early on and having them integrated later. Secondly, brain systems have physical limitation and constraints, and using different circuits to get specialized and condensed information is more efficient. Third, it might able to reduce the noise. If the processing is within one circuit, the noise might be accumulated. When different information is processed in parallel, it might be easier to filter noise respectively. (360, Nassi)

2. **Dorsal and ventral visual pathways were originally thought to serve different functional purposes, what were they? Yet, certain visual properties are processed within both pathways, such as binocular disparity. Why is that?**

Originally, scientists thought that the dorsal pathway processes spatial information, and is called “where” pathway, whereas ventral pathway processes information about object identification and recognition, and is therefore called “what” pathway. Recently, it is found that both pathways might processing similar visual attributes but for different behavioral goals. Some visual properties are found to be processed within both pathways, such as binocular disparity, motion-related and shape-related computations. For binocular disparity, since it is used to extract depth information, it can certainly be used by both pathways. For example, dorsal pathway can use the information for spatial orientation and guide actions, and ventral pathway can use the depth for three-dimensional shape perception. (367, Nassi)

3. **When there are two stimuli within a visual neuron's receptive field, one preferred and one not preferred, how is neural response modulated by attention? What is the evidence that there is suppression induced by attending to the non-preferred stimulus (as opposed to a relatively smaller enhancement of response when compared to attending to the preferred stimulus)?**

The preferred stimuli will have increased response when attention is directed, and the non-preferred stimuli will be suppressed. (297) The evidence is shown in the experiment that records neuron response in cells from MT and MST. When viewing two half circles with one has the preferred motion and the other is not, monkeys’ neuron have higher firing rate for preferred motion when attention is directed and less firing rate for non-preferred, as compared to the firing rate when viewing a square outside the circle. (296, Figure 1)
4. In what sense does the attentional narrowing of tuning curves increase the neuron's selectivity? In what sense does the multiplicative increase of a neuron's response increase the amount of information communicated by the neuron?

When the tuning curve is narrowed, it means that a neuron has higher response in preferred stimuli and has less response to non-preferred. For example, a neuron fires even more for certain direction and less for others, as compared to no attention. Thus, the neuron is more “selective” to its preferred direction due to attention. For the multiplicative increase, the under attended stimuli, neurons have increased response for all direction of motion and orientations. Thus, the amount of information is increased, since the non-preferred stimuli is not suppressed due to attention (Figure 2, 297)

5. (Extra credit) Attentional modulation appears to increase higher up in the visual hierarchy. Why is this (we discussed this in class)?

One reason might be that the higher level perception occurs in the higher visual hierarchy, where all information is integrated. Attentional modulation is more useful when applying to the area where all information is perceived and understood. Therefore, it increases higher up in the visual hierarchy. Also, probably when measuring the attention modulation in the higher level area, the signals are accumulated from the earlier area, and thus it is increase.

6. (Extra credit) How is featural attentional different from spatial attention? Why is the discovery of featural attention challenging for the "spotlight of attention" analogy?

Featural attention means that some expected or relevant feature of the stimuli is also influenced by attention, such as cued color, whereas spatial attention correspond to the spatial attributes of stimuli when attention is tested. According to the experiment, feature-based attention seems to enhance the response for all neurons, but not just for those in the receptive fields. Therefore, the feature based attention modulation might combine with spatial based attention modulation during experiments. (298)

7. (Extra credit) How can apparently nonlinear attentional modulation of neural response arise from multiplicative modulation in an earlier area?

Because the sensory coding is also non-linear in an earlier area, as the contrast response function is a sigmoidal shaped curve. From the multiplicative modulation, the non-linear sensory coding can create the non-linearity in the attention modulation (299)