Petersen (2007)
1. Describe the pros and cons of each of the following technologies for measuring neural responses, and give specific examples in the study of rodent barrel cortex: multi-electrode arrays, intrinsic optical imaging, voltage-sensitive dye imaging, calcium imaging.
With multi-electrode arrays the pros are high spatial and temporal resolution and the cons are you cannot record from all cells you have to measure small areas at a time so the spatial is limited.
With intrinsic optical imaging the pros are higher spatial resolution, least invasive, and cheap. The cons has poor time resolution and indirectly related to neural activity.
With voltage-sensitive dye imaging, the pros are high spatial and temporal resolution and the disadvantages are it is superficial and there is a discrepancy between this and the previous methods leading to a problem differentiating the supra and sub thresholds.
Calcium Imaging- advantages: allows you to picture the action potential activity of individual neurons within a network allowing to create a finely tuned function map.
Disadvantages:

2. What is the evidence that the patterning of the barrel cortex is under the control of both genetic and experience-dependent factors?
Genetic: After a few days from birth, the barrel map is developed and fixed. Studies have shown even with peripheral lesions there is little difference on the somatotopic layout.
Experience - dependent factors: When the rat only had one whisker and explored the home cage the barrell expanded after a month of roaming its home cage. Whereas, when periodically introduced to a novel cage in the same amount of time the barrel actually reverse and minimized in size. This shows that experience with the environment has an effect on the barrel structure.

3. Give four examples of the barrel somatosensory system anticipating/predicting future sensory events and encoding a prediction error based on experienced outcomes.
When the rats are approaching an aperture, object detection and location, and texture discrimination.

4. (Extra credit) Speculate why only the medial barrels in S1 have reciprocal connections with the contralateral barrel cortex. What function might this cross-talk serve?

1. What is the evidence from Shams & Seitz (2008) that visual-auditory training benefits learning in visual discrimination?
When training to visually discriminate types of birds, the training paired with auditory actually enhanced discrimination compared to just visual training. This is opposite to the belief that sound
would be a distractor but because it’s another feature it helps a person discriminate with more information.

2. How was it shown that the benefit of visual-audio training is not merely due to the presence of auditory stimulus (in addition to visual stimulus), but rather contingent on it being semantically congruent with respect to the visual stimulus?
Seitz and Shams tested learning across three conditions- just visual, visual motion and auditory in congruent (same direction), and visual motion and auditory in incongruent (opposite directions). The results of this task showed that the congruent task within and across sessions improved the training more so than incongruent and the visual only stimulus. (Figure 1, pg 2 Shams & Seitz (2008))

3. What result from Shams et al (2002) established that the visual stimuli were not ambiguous or that they by themselves were too difficult for the subjects to correctly perceive?
When they ran the condition of zero beeps and only flashes and asked for the perceived flashes. This data shows that the participants almost always perceived the correct amount of flashes till about 3 flashes, closer to 4 flashes could potentially be a bit more difficult since it’s not quite at 4. (Figure 4a, pg 149 Shams et al (2002))

4. How did they establish that subjects were not simply responding to the auditory stimulus and ignoring the visual stimulus?
To establish that the subjects weren’t just responding to the auditory stimulus they ran the condition of 1-4 flashes with only 1 beep presented. The results showed that the perceived number of flashes was still close accurate to the actual number of flashes. (Figure 4b, pg 149 Shams et al (2002))

5. (Extra credit) What is the evidence that visual-auditory interactions in sound-induced flash illusion is asymmetric (in terms of numerosity)? Why does this provide evidence against the "modality appropriateness" hypothesis?
There are times with the auditory influences the visual in that the presence of 2 flashes can be perceived at 1 flash when 1 auditory beep is presented. This is against the “modality appropriateness” hypothesis because the hypothesis states that the more dominant modality will determine the perception, however in this case it doesn’t. Vision is the most dominant modality we use if following this hypothesis, we should perceive 2 beeps with 2 flashes not the opposite where we perceive 1 flash to 1 beep.

General
1. Specificity in neural computation and representation often go hand in hand with a certain
degree of information loss. Discuss why this is often the case and give examples from two different sensory modalities (among vision, olfaction, somatosensation).

Representation and information loss generally go hand in hand because we cannot store all the sensory information we receive or it is not relevant to us. One example, the visual system is constantly receiving overwhelming amounts of external information. In order to modulate attention, we have to break down this information into more selective information in the LGN to have the most efficient visual experience. If we processed everything, we wouldn’t be able to focus and attend to more relevant things.

Another example of this is with the olfactory system, there are loose binding mechanisms that allow the receptors to quickly process through odorants however, sensitivity is lost because of this. The computation of odorants can require more effort and thus we lose the some of the odorant information through the computational mechanisms.

2. Our understanding of what neurons encode is often limited by what kind of sensory stimuli we probe the system with. Give examples from two different sensory modalities (among vision, olfaction, somatosensation).

3. In what sense is understanding the neural coding of olfactory processing particularly difficult compared to the other sensory modalities?

Neural coding of olfactory is particularly difficult because odorants can’t be broken down like visual information can be. Odorants are complex and so far we know that they are processed by the physical structures and there aren’t specific structures that relate to specific odorants. Similar structures can have completely different perceptions. The receptors that handle this process have multiple bindings making it difficult to study specificity of odorants since they processed through receptors that bind with multiple structures. There doesn’t seem to be a consistent area or type of odorant mapping.

4. (Extra credit) Neural processing in sensory systems is often thought of as feedforward and linear: increasingly complex and sophisticated from the sensory periphery to "higher" levels of processing. Give three distinct examples from the course that go against this default view.