1. For LGN, which structures provides a). Feedforward, b). Feedback, c). Recurrent input? Why is it categorized this way?

   Feedforward information is received from retina, and feedback is from further down the pathway such as topdown cortex input. Recurrent input (inhibition) is provided by inhibitory interneurons (TRN) that forms a local recurrent inhibitory loop, which then inhibit LGN relay neurons. It is categorized this way based on the direction of information flow. For example, the outside information hits the retina first and then “forwards” to the LGN, whereas cortex is more higher up in the process, so it feeds “back” to LGN. It is organized in this way to achieve temporal diversity.

   Ok, but recurrent input can also be excitatory

2. Define efficacy of the retinogeniculate drive. How does it depends on animal’s sleep/arousal state? Why does it never reach 100% in awake behaving animals?

   Efficacy is the ratio of LGN spike/retinal spikes (143). For example, if we say that LGN is operating at 50% efficacy, that means LGN ignores the retina half of the time (136). Efficacy increases as state moves from slow-wave sleep to REM or wakefulness (143). It never reaches 100% because if LGN correspond to retinal spikes 100%, then there’s no need for LGN, we can just have the RGC itself have a longer axon and pass on the same information. Lower than 100% efficacy actually indicate some computation done at LGN.

3. Can LGN provide more information than retina, why or why not?

   Yes, LGN can provide more information than retina, this is because of top-down information received from cortex, such as input from other sensory modality other than visual input. Retina has only one input, which is from the environment. LGN, however, has both the feedforward information from the retina, but also the feedback information from cortex. This means retina can only encode information that represents the current state (“now”), whereas the LGN can encode information that represents both now and the past (from the cortex).

4. Why is it useful for the LGN to provide “efficient access...to selective population of retinal groups. “ (P.2)? Give one example

   It is useful because there’s lots of redundancy in the real world input. By having efficient access to selective population of retinal groups, selective attention (contextual modulation) can happen as early as in LGN. LGN does so by parsing and segregating retinal inputs. For example, if we are asked to pick out a moving red dot among many noisy stimuli, because of parsing and segregating retinal inputs, we are able to pick the features we are looking for -- red and moving (maybe towards a specific direction) at the same time, and ignores any stimuli that is not red, or not moving. By having efficient access to selective population of retinal groups, LGN allows us to respond much quicker than having to search through all features in the provided example.

4.5/5

5. (Extra credit) What does it mean that LGN cells have higher gain at lower contrast, and lower gain at higher contrast? What function does it serve and why?

   This describes the LGN cells’ contrast gain control function. Higher gain at lower contrast and lower gain and high contrast means that the LGN cells increase their response (the
slope/gradient of the curve) much quicker when the contrast is low, and increase their response much slower when the contrast is high. If we plot this with the x-axis being contrast, and y-axis being the response, we would have a series of sigmoid functions with decreasing slopes as x increases, instead of a linear function. This helps to reduce noise range and normalize response.

6. (Extra credit) How do lagged and non-lagged cells differ in their anatomical connections from the retina? What differential function might they serve (see slide 10)?

Non-lagged cells receive input from the retina directly, whereas lagged cells receive input from the retina and the inhibitory interneurons. Lagged cells project to visual cortex via slowly conducting axons (146). Glomerruli were much more numerous on lagged than nonlagged X-cells. Compared to lagged cells, non-lagged cells have larger axons. Combining lagged and nonlagged cell inputs in cortex can generate direction-selective neurons(147). When the levels of luminance change, nonlagged cells show excitatory transient response to a spot flashed at four levels of luminance, whereas lagged cells shows a more sustained level of firing pattern responding with an inhibitory, followed by a slow build in activity (slide 10). This indicates that nonlagged cells encode transitions from light to dark, whereas lagged cells encode long term averaged state.

7. (Extra credit) Why might there be inter-species differences in how much multiplexing or integration there is in the LGN (as opposed to downstream in the visual pathway)?

One advantage of multiplexing is to be selective with the information, which means there’s a loss in raw information, but a gain in specificity. If there’s more computation done at the level of LGN with multiplexing and integration, then there’s less needs to be done at the downstream processing. We know that multiplexing is much more common in cats than in monkeys. Monkeys have much bigger cortex compared to cats, which indicates that there’s much more computational power downstream at the cortical level. So it is possible that even with very little multiplexing, monkeys’ cortex can handle much more raw information to compute than cats brain.