Sample Solutions for Sensory System Practice Problems:

1. Some insects detect sound using a Johnson's organ located at the base of their antennae. Consider the similarities and differences in the Johnston's organ and the mammalian ear. Is the sensory neuron of a scolopidia more similar in function to an inner hair cell or an outer hair cell of the mammalian organ of Corti? Explain.

Inner hair cell
Both inner hair cells and scholopidia sensory neurons transduce mechanical stimuli

- into changes in membrane potential
- using mechanosensitive ion channels that are pulled open
- in response to movement induced by sound waves

Not outer hair cells because they transduce mechanical stimuli into movement

4. Destruction of the tip links on the stereocilia of hair cells in the inner ear results in hearing loss. Explain why.

- Tip links connect the mechanosensitive K^+ channels on one stereocilium to those on the adjacent stereocilium
- Incoming sound waves cause the stereocilia to bend back and forth
- When the stereocilia bend towards the kinocilium, the tip links are stretched
- Which pulls the channels open
- K^+ enters and depolarizes the cell
- Depolarization stimulates increased neurotransmitter release onto the sensory neuron (by opening voltage-gated Ca^{2+} channels)
- Stimulating a higher frequency of action potentials sent to the brain – perceived as sound
- If the tip links are destroyed, bending of the stereocilia will no longer pull open mechanosensitive K^+ channels
- No depolarization of the hair cell in response to sound, so no change in AP frequency of the sensory neuron
- The brain does not perceive a sound in the presence of a sound signal – this is hearing loss

5. Typically, the human retina has four types of photopigment. Deuteranomaly is a condition in humans caused by a loss of function mutation in the gene for one type of photopigment. Individuals with this condition are unable to distinguish between certain colours, such as green and red. (Deuteranomaly is the most common form of "red-green colour blindness".)

a) In which type of photoreceptor (rod or cone) would you expect to find this non-functional photopigment? Explain why you would **not** expect to find this non-functional photopigment in the other type of photoreceptor.

Cones

Not rods, because rods only have one type of photopigment.
If the rods photopigment was non-functional then none of the rods could detect light and so the individual would not be able to see in dim light (but colour vision and vision in bright light would be fine)

b) Why would having one type of non-functional photopigment cause someone to be unable to distinguish between certain colours? Explain.

- Humans have three classes of cone photoreceptor
- Each class of cone contains one of the three types of photopigment
- Each of these three types of photopigment is sensitive to a different range of light wavelengths
- The brain perceives the colour of any given wavelength of light by comparing the relative stimulation of the three classes of cones
- If one of the three classes of cones has non-functional photopigment, then that class of cone will not be stimulated by light
- So the brain can only compare the relative stimulation of two classes of cones, not three
- This would reduce the ability to distinguish between light wavelengths falling within the range normally detected by the non-functional photopigment