Answer all questions. You may respond in Chinese or English. (100 points total)

1. Vision (33 points total)

a) 研究神經的視覺受域(visual receptive field)對瞭解大腦如何處理視覺訊息非常重要。請說明下列兩種神經其視覺受域的特性，以及形成該視覺受域的神經機制為何。i) 視網膜雙極細胞(retinal bipolar cells)；ii) 主要視覺區簡單細胞(V1 simple cells)。*(11 points)*

b) 中側腦區(Middle Temporal Area, MT)的神經主要負責偵測物體的運動方向。請問: i) MT 神經的反應特性為何[以隨機點(random dots)或移動光柵(moving gratings)刺激為例]? ii) MT 神經主要接收來自於哪些大腦結構的訊息? iii) 如果動物在偵測刺激的運動方向時，以電刺激讓 MT 神經的反應增強，動物的偵測行為會受到什麼影響? *(11 points)*

c) 視覺的腹側路徑(Ventral Pathway)主要腦區有 V2、V4、以及 IT (inferior temporal area)。請針對每一個腦區，回答下列問題: i) 各腦區神經反應特性為何? ii) 你會使用什麼樣的視覺刺激，去測量該腦區的神經特性? iii) 請透過這些腦區之間的連結，說明產生"binding problem"的可能神經機制為何? *(11 points)*

2. Somatic Sensation (33 points total)

a) The perception of touch depends on the cerebral processing.

i) Mapping of specific parts of the body to areas of the cortex is known as somatotopy. In a sketch of coronal section of the human brain, please mark the approximate mapping locations in the primary somatosensory cortex for the right face, right hand, and right foot. *(3 points)*

ii) Ample evidence has indicated hemispheric lateralization during processing tactile information in humans. What is hemispheric lateralization? *(3 points)*

iii). Briefly describe one experimental design to demonstrate that some brain regions responsive to tactile stimulation are lateralized. *(7 points)*

b) Cognitive operation of pain is a two-way street, which contains top-down and bottom-up processing. One of the key cognitive factors is attention. Please describe how top-down and bottom-up attention influences human perception of pain. *(10 points)*

c) The gate control theory, which is proposed in 1965 by Ronald Melzack and Patrick Wall, is one of the most influential theories of pain that most accurately accounts for the psychophysical aspects of pain perception in humans.

i) Please explain this theory. *(7 points)*

ii) Please give an example in our daily life. *(3 points)*

3. Learning and Memory (34 points total)

a) In the cognitive sciences, human memory is divided into various different types. Describe these different types of memory. In your answer, provide clear definitions, examples of how these types of memories might be acquired, how they work, and contrast the key features that distinguish each type of memory from the others. *(24 points)*

b) In animal studies on reward learning, dopamine neurons in the frontostriatal regions fire at first to unconditioned stimuli (US; e.g. receiving apple juice). After several trials of pairing with conditioning stimuli (CS; e.g. a light that precedes the juice), the neurons then fire to the CS, but show no change in baseline firing to subsequent encounters with the US. Also, if a CS is encountered, but no US occurs, the neurons suppress their activity instead. Describe how this pattern of firing activity instantiates learning. In your answer, consider how dopamine neurons respond to information in order to change mental representations (e.g. memory) and/or subsequent behavior. *(10 points)*