

Exercises for **BIO-499: Neural Circuits of Motivated Behaviors**

Teachers: Ralf Schneggenburger and Olexiy Kochubey

TAs: Jinyun Wu, Runzhong (Yvonne) Zhang

Unit 1 – Brain anatomy

1) Name 5 major divisions of the brain, and 2 brain areas located in each division.

2) Make a drawing of the mouse cortex from the top, and indicate the approximate location of:

- Prefrontal cortex
- Motor cortex
- Primary somatosensory cortex
- Primary auditory cortex
- Primary visual cortex

3) Make a similar drawing of human cortex. Name the location of the 5 cortical area mentioned in question

2. In addition, point out 3 important association areas.

4) Name 3 important types of pyramidal cells in the cortex. Where do they project to? In which layers are they localized?

5a) What is the definition of a "principal neuron", and of an "interneuron".

5b) In the cortex, which neurotransmitter is used by principal neurons, and by interneurons?

6) Name which thalamic areas transmit i) somatosensory, ii) auditory, and iii) visual) information to the corresponding primary sensory cortices.

7) Explain what the "Cerebral nuclei" are. How they are derived during ontogenesis, which neurotransmitter do these neurons primarily use, and in which brain division are the cerebral nuclei localized?

8) Explain how the "direct pathway" through the basal ganglia works. Name inputs, neuron types, and outputs. Which thalamic structures are involved in this cortex-basal ganglia-thalamus-cortex loop?

9) Explain the trisynaptic pathway of the hippocampus, including its main input and output structures.

10) Name 2 "cortical-like" and 2 "striatal-like" sub-areas of the amygdala.

11) Using the Allen Brain Mouse reference atlas at <https://atlas.brain-map.org/atlas>

Find the first and last slices containing the following nuclei. Also name in which brain division (color code!) each nucleus / cortical area is localized.

Nuclei	Acronym	Brain Division	Start	End
Main Olfactory Bulb	MOB			
Prelimbic area	PL			
Infralimbic area	ILA			
Nucleus Accumbens	ACB			
Primary somatosensory area	SSp			
Caudoputamen	CP			
Supplemental Somatosensory area	SSs			
Fornix system	fxs			
Central Amygdala	CEA			
Basolateral Amygdala	BLA			
Dentate Gyrus	DG			
Lateral Amygdalar nucleus	LA			
Ventral Posterolateral nucleus	VPL			
Auditory areas	AUD			
Periaqueductal Gray	PAG			
Ventral tegmental area	VTA			
Medial Geniculate Nucleus	MG			
Superior colliculus, sensory related	SCs			
Parabrachial Nucleus	PB			

12) The Allen brain atlas also has in-situ hybridization data for a variety of genes:

vGAT <https://mouse.brain-map.org/experiment/show/72081554>

vGluT1 <https://mouse.brain-map.org/experiment/show/75081210>

vGluT2 <https://mouse.brain-map.org/experiment/show/73818754>

Based on the expression of these 3 genes, state which of the below brain structures have GABAergic-, and which have glutamatergic neurons as their principal neurons. Explain your decisions.

	Principal neuron GABAergic	Principal neuron glutamatergic
CEAI		
LA		
CP		
AUDp		

13) Compare the expression of vGluT1 and vGluT2 in the cortex and thalamus. Describe which of the two isoforms is primarily expressed in the cortex, and in the thalamus.

14) Check the expression of Drd1 and Drd2 in the Striatum (CP). What can you say about the localization of direct, and indirect pathway neurons?

Drd1: <https://developingmouse.brain-map.org/experiment/show/352>

Drd2: <https://developingmouse.brain-map.org/experiment/show/357>