

# 260-2017-01-20-neuranatomy

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## Prelude

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## Today's topics

- Logistics for Monday and Wednesday
- Wrap up on functional methods
- Neuroanatomy
  - Through song and dance

## Next week's logistics

### Mon, January 23

- A-L: Tour of Social, Life, & Engineering Sciences Imaging Center (SLEIC). Meet in lobby of Chandlee.
- M-Z: Neuroanatomy Lab

### Wed, January 25

- A-L: Neuroanatomy Lab
- M-Z: Tour of Social, Life, & Engineering Sciences Imaging Center (SLEIC). Meet in lobby of Chandlee.

## Wrap-up on functional methods

Which of the following methods has *temporal* resolution on the order of seconds?

- A. functional MRI
- B. EEG
- C. MEG
- D. single-unit recording

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Which of the following methods has high/fine *spatial* resolution?

- A. functional MRI
- B. PET
- C. EEG
- D. Optogenetic stimulation

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### Evaluating stimulation methods

- Spatial/temporal resolution?
  - Assume stimulation mimics natural activity?
  - Optogenetic stimulation highly similar, others less so
- Deep brain stimulation as therapy
  - Parkinson's Disease
  - Depression
  - Epilepsy

### Deep brain stimulation

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Effects of DBS for Parkinson's.

### Simulating the brain

- Computer/mathematical models of brain function
- Example: neural networks
- Cheap, noninvasive, can be stimulated or “lesioned”

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Convolutional neural network.

### Spatial and Temporal Resolution

[(Sejnowski, Churchland, and Movshon 2014)](<http://doi.org/10.1038/nm.3839>)

# Neuroanatomy

## Brain anatomy through dance

### Finding our way around

Anterior/Posterior

Medial/Lateral

Superior/Inferior

Dorsal/Ventral

Rostral/Caudal

### Directional image

[https://upload.wikimedia.org/wikipedia/commons/thumb/e/e7/Blausen\\_0019\\_AnatomicalDirectionalReferences.png/800px-Blausen\\_0019\\_AnatomicalDirectionalReferences.png](https://upload.wikimedia.org/wikipedia/commons/thumb/e/e7/Blausen_0019_AnatomicalDirectionalReferences.png/800px-Blausen_0019_AnatomicalDirectionalReferences.png)

### Bipeds vs. quadripeds

[https://upload.wikimedia.org/wikipedia/commons/thumb/0/00/1303\\_Human\\_Neuroaxis.jpg/800px-1303\\_Human\\_Neuroaxis.jpg](https://upload.wikimedia.org/wikipedia/commons/thumb/0/00/1303_Human_Neuroaxis.jpg/800px-1303_Human_Neuroaxis.jpg)

### No matter how you slice it

Horizontal/Axial

Coronal/Transverse/Frontal

Sagittal (from the side)

### Slice diagram

[http://www.scienceteacherprogram.org/biology/chillemistudentguide1-06/brain\\_directions\\_planes\\_sections\\_\\_\\_directions\\_-\\_small.gif](http://www.scienceteacherprogram.org/biology/chillemistudentguide1-06/brain_directions_planes_sections___directions_-_small.gif)

## **Supporting structures**

**Meninges**

**Ventricular system**

**Blood supply**

**Meninges**

**Dura mater**

**Arachnoid membrane**

**Subarachnoid space**

**Pia mater**

**Meninges**

<https://upload.wikimedia.org/wikipedia/commons/thumb/8/8e/Meninges-en.svg/1280px-Meninges-en.svg.png>

**Ventricular system**

[https://upload.wikimedia.org/wikipedia/commons/d/d4/Blausen\\_0896\\_Ventricles\\_Brain.png](https://upload.wikimedia.org/wikipedia/commons/d/d4/Blausen_0896_Ventricles_Brain.png)

**Ventricles**

**Lateral (1st & 2nd)**

**3rd**

**Cerebral aqueduct**

**4th**

**Cerebrospinal fluid (CSF)**

- Clears metabolites during sleep (Xie et al. 2013).

**Blood Supply**

[http://surgery.med.miami.edu/images/Circulation\\_of\\_brain.gif](http://surgery.med.miami.edu/images/Circulation_of_brain.gif)

**Blood Supply**

**Arteries**

- Circle of Willis

## Blood/brain barrier

- Cells forming blood vessel walls tightly packed
- Active transport of molecules typically required

## Blood/brain barrier

<http://www.nature.com/nrn/journal/v7/n1/images/nrn1824-f3.jpg>

## Area Postrema

- Brainstem, blood-brain barrier thin

## Area Postrema

<http://www.nature.com/nrendo/journal/v9/n10/images/nrendo.2013.136-f2.jpg>

## Organization of the Nervous System

### Central Nervous System (CNS)

- Brain
- Spinal Cord
- Everything encased in bone

### Peripheral Nervous System (PNS)

## Organization of the brain

Major division	Ventricular Landmark	Embryonic Division	Structure
Forebrain	Lateral	Telencephalon	Cerebral cortex Basal ganglia Hippocampus, amygdala
	Third	Diencephalon	Thalamus Hypothalamus
Midbrain	Cerebral Aqueduct	Mesencephalon	Tectum, tegmentum

## Organization of the brain

Major division	Ventricular Landmark	Embryonic Division	Structure
Hindbrain	4th	Metencephalon	Cerebellum, pons
	–	Myelencephalon	Medulla oblongata

## Hindbrain

### Structures adjacent to 4th ventricle

- Medulla oblongata
  - Cerebellum
  - Pons
- 

## Medulla oblongata

[https://upload.wikimedia.org/wikipedia/commons/6/69/1311\\_Brain\\_Stem.jpg](https://upload.wikimedia.org/wikipedia/commons/6/69/1311_Brain_Stem.jpg)

## Medulla

- Cardiovascular regulation
- Muscle tone
- Fibers of passage
- Cranial nerves VI-XII

## Cerebellum

- “Little brain”
  - Dorsal to pons
  - Movement coordination, simple learning
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## Pons

- Bulge on brain stem
- Neuromodulatory nuclei
- Relay to cerebellum
- Cranial nerve V

## Midbrain

<http://antranik.org/wp-content/uploads/2011/11/the-brain-stem-mid-brain-left-lateral-view-superior-colliculus-inferior-cerebellum.jpg>

## Midbrain components

### Tectum

### Tegmentum

### Tectum

<https://upload.wikimedia.org/wikipedia/commons/0/0b/Gray719.png>

## **Tectum**

- Tectum -> “roof”
- Superior and inferior colliculus
- Reflexive orienting of eyes, head, ears

## **Tegmentum**

- Tegmentum -> “floor”
- Species-typical movement sequences
- Cranial nerves III, IV
- Neuromodulatory nuclei
  - Dopamine (DA)
  - Norepinephrine (NE)
  - Serotonin (5-HT)

## **Forebrain**

<http://classconnection.s3.amazonaws.com/252/flashcards/1048252/png/forebrain1328987872235.png>

## **Forebrain Components**

### **Diencephalon**

### **Telencephalon**

### **Diencephalon**

[https://upload.wikimedia.org/wikipedia/commons/a/a0/1310\\_Diencephalon.jpg](https://upload.wikimedia.org/wikipedia/commons/a/a0/1310_Diencephalon.jpg)

## **Diencephalon Components**

- Thalamus
- Hypothalamus

## **Thalamus**

<http://neurobiologychapter3.weebly.com/uploads/1/4/1/8/1418733/5118342.jpg?401x231>

## **Thalamus functions**

- Input to cortex
- Functionally distinct nuclei (collection of neurons)
- Lateral geniculate nucleus (LGN), vision
- Medial geniculate nucleus (MGN), audition

## Hypothalamus

- Four Fs: fighting, fleeing, feeding, and reproduction
- Controls pituitary gland (“master” gland)
  - Anterior (indirect release of hormones)
  - Posterior (direct release of hormones)
    - \* Oxytocin
    - \* Vasopressin

## Hypothalamus

[http://higheredbcs.wiley.com/legacy/college/tortora/0470565101/hearthis\\_ill/pap13e\\_ch14\\_illustr\\_audio\\_mp3\\_am/simulations/figures/hypothalamus.jpg](http://higheredbcs.wiley.com/legacy/college/tortora/0470565101/hearthis_ill/pap13e_ch14_illustr_audio_mp3_am/simulations/figures/hypothalamus.jpg)

## Next time...

- SLEIC or neuroanatomy lab

## References

Sejnowski, Terrence J, Patricia S Churchland, and J Anthony Movshon. 2014. “Putting Big Data to Good Use in Neuroscience.” *Nature Neuroscience* 17 (11). Nature Publishing Group: 1440–1. doi:10.1038/nn.3839.

Xie, Lulu, Hongyi Kang, Qiwu Xu, Michael J Chen, Yonghong Liao, Meenakshisundaram Thiyagarajan, John O’Donnell, et al. 2013. “Sleep Drives Metabolite Clearance from the Adult Brain.” *Science* 342 (6156). American Association for the Advancement of Science: 373–77. doi:10.1126/science.1241224.