Neural Engineering

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Please vote for office hours and grading

Lecture 2, 080131

More details:

- I'd like you to take notes, but I will also give you mine. My notes won't be as detailed as what I write during class.
- Homework, new syllabus and notes are available here:

http://complex.gmu.edu/people/peixoto

- If you have problems downloading files write to me! npeixoto@gmu.edu

The Braingate paper

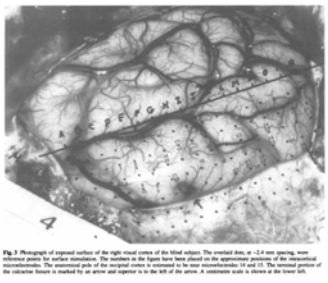
- Did the videos help?
- What did you think? Too hard/too easy?

Trepanation

http://scienceblogs.com/neurophilosophy/Johannes_Scultetus_trepanation.jpg
http://i61.photobucket.com/albums/h53/mocost/crown_trepan.jpg

Neural prosthesis

Two types:
- Sensory
- Motor



From Schmidt et al, Brain, 1996.

The basics (chapter 1)

- Sensory and motor prosthesis
- What's with receptors in postsynaptic neurons?
- Neurons and glia
- EPSPs, IPSPs, APs
- Block diagram of a generic implant
- Design criteria
- Interfaces with the nervous system
- Bottlenecks

Cerebral cortex

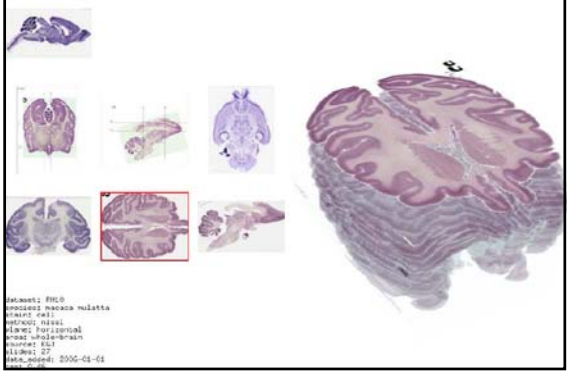
The **cerebral cortex** is a brain structure in vertebrates. In non-living, preserved brains, the outermost layers of the cerebrum has a grey color, hence the name "grey matter". Grey matter is formed by neurons and their unmyelinated fibers while the white matter below the grey matter of the cortex is formed predominantly by myelinated axons interconnecting different regions of the central nervous system. The human cerebral cortex is 2-4 mm (0.08-0.16 inches) and plays a central role in many complex brain functions including memory, attention, perceptual awareness, "thinking", language and consciousness.

Slice of the cerebral cortex, ca. 10.5mm wide

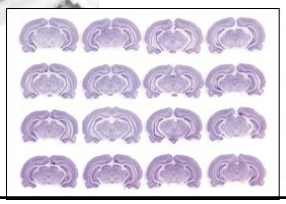
Location of the cerebral cortex

The surface of the cerebral cortex is folded in large mammals like humans, where

Cerebral cortex

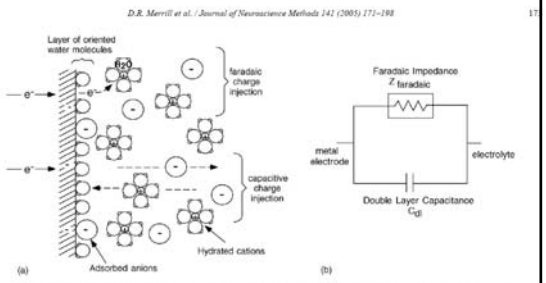


Multi-brain histology



From: www.nsalabs.com

Electrode – electrolyte interface



Selecting a project

- Previous projects:
  - Deep brain stimulation
  - Epiretinal implants
  - Carbon nanotubes for single cell analysis
  - Microarrays with Si-pyramids
  - Electrophoretic manipulation of cells
  - MRI for IQ determination in children
  - Control of prosthetic devices

Case Study

- Deep brain stimulation is used for treating several diseases.
- It is not well characterized.
- Main problems: positioning of the electrodes, understanding of the mechanical and electrical (primary and secondary) effects.
- Example: morbid obesity.

Memory Enhancement Induced by Hypothalamic/ Fornix Deep Brain Stimulation

Clement Hamani, MD, PhD,[1] Mary Pat McAndrews, PhD,[2] Melanie Cohn, PhD,[2] Michael Oh, MD,[1] Dominik Zumsteg, MD,[3] Colin M. Shapiro, MD, PhD, FRCPC,[4] Richard A. Wennberg, MD, FRCPC,[3] and Andres M. Lozano, MD, PhD, FRCSC[1]

Bilateral hypothalamic deep brain stimulation was performed to treat a patient with morbid obesity. We observed, quite unexpectedly, that stimulation evoked detailed autobiographical memories. Associative memory tasks conducted in a double-blinded "on" versus "off" manner demonstrated that stimulation increased recollection but not familiarity-based recognition, indicating a functional engagement of the hippocampus. Electroencephalographic source localization showed that hypothalamic deep brain stimulation drove activity in mesial temporal lobe structures. This shows that hypothalamic stimulation in this patient modulates limbic activity and improves certain memory functions.

Ann Neurol 2008;63:119–123

Definition of morbid obesity (severe chronic obesity)

- Adults with a BMI greater than 30 are considered obese.
- Anyone more than 100 pounds overweight or with a BMI greater than 40 is considered morbidly obese.

http://www.nlm.nih.gov/medlineplus/ency/article/007297.htm

Options (morbid obesity): gastric bypass, bariatric surgery

Bariatric surgery *(bear-ee-AT-ric) Also known as gastrointestinal surgery.* Surgery on the stomach and/or intestines to help patients with extreme obesity to lose weight. Bariatric surgery is a weight-loss method used for people who have a body mass index (BMI) above 40. Surgery may also be an option for people with a BMI between 35 and 40 who have health problems like heart disease or type 2 diabetes.

Discussion next class – be prepared

- "Microelectrode array for chronic deep-brain microstimulation and recording"

McCreery et al, IEEE TBE, 2006, vol 53, 4, pg 726.