- List of lectures and readings – see the syllabus!

- Lecture slides posted online before the lecture – **print** (4 or 6 slides per page), bring to lecture, take notes directly on printout, and **actively participate**.

- **Best way to succeed in this course**

  - [www.psych.ubc.ca/~ksoma](http://www.psych.ubc.ca/~ksoma)

**Slides will be missing critical information (that will be on the exams).**
• **During lectures, please *turn off and put away***
  • phones
  • laptops
  • tablets

• **Actively participate in class**
  • Questions during lectures are highly encouraged.
  • We are off to a great start; let’s continue in that direction!

• Please do not get ready to go before the lecture is finished.

• **Please do not arrive late**
Neuroanatomy I

https://www.youtube.com/watch?v=xB7rXw_3gVY&list=PL242bEng6nyldshvi_ZUid_i3YctT75q9&index=1
http://www.med.ubc.ca/now-streaming-ubcs-distinctive-lens-on-neuroanatomy/
http://www.ubc.ca/stories/2016-fall/claudia-krebs.html
http://www.neuroanatomy.ca/

Nissl stain

Male zebra finches sing, but females do not.

Adult male

Adult female
In situ hybridization to detect mRNA

messenger RNA = mRNA

DNA → mRNA → protein
Immunohistochemistry to detect proteins
Scientists use modified viruses to map the connections between cells. Researchers altered an adeno-associated virus (AAV) to introduce green fluorescent protein (GFP) into Purkinje cells (pictured in green above) in the mouse cerebellum — a region that plays a role in motor control.
Human Nervous System

Central Nervous System (brown)
- Brain
- Spinal cord

Peripheral Nervous System
- Somatic (blue): Controls voluntary muscles and conveys sensory information to the central nervous system
- Autonomic (red): Controls involuntary muscles
  - Sympathetic: Expends energy
  - Parasympathetic: Conserves energy
Vertebrate Nervous System

• Central nervous system (CNS)
  – spinal cord and brain
  – protective covering and bone
  – fluid-filled spaces

• Peripheral nervous system (PNS)
  – connects CNS to rest of the body
  – Somatic nervous system: conveys messages from sense organs to CNS & from CNS to muscles
  – Autonomic nervous system: controls the heart, intestines, and other organs
Anatomical Directions
Key terms in neuroanatomy

1. Ventral: toward the stomach
2. Dorsal: toward the back
3. Caudal: toward the tail
4. Rostral: toward the nose
5. Medial: toward the middle
6. Lateral: toward the side
7. Superior: on the top
8. Inferior: on the bottom
9. Ipsilateral: on the same side
10. Contralateral: on the opposite side
11. Bilateral: on both sides
12. Unilateral: on one side
LH?
VMH?
Rat B is normal weight. Bilateral lesions to which region produced rat A? What happened to rat B?
Spinal Cord

• Part of CNS found within spinal column
  – Communicates with the sense organs and muscles, except those of the head
  – Entering dorsal roots carry sensory information and exiting ventral roots carry motor information
  – Cell bodies of the sensory neurons are located in clusters of neurons outside the spinal cord – dorsal root ganglia
5 Major Divisions

Cervical (8 segments)
Thoracic (12)
Lumbar (5)
Sacral (5)
Coccygeal (1-2)
Cross-Section Through the Spinal Cord

- Gray matter
- White matter
- Sensory nerve
- Dorsal root ganglion
- Central canal
- Dorsal
- Ventral
- Motor nerve
Major Divisions of the Vertebrate Brain
Hindbrain

- Consists of the:
  - Medulla
  - Pons
  - Cerebellum

- Located at posterior portion of the brain
- Makes up the “brain stem,” along with midbrain and parts of the forebrain
• Just above spinal cord
• Controls vital reflexes
  – Breathing
  – Heart rate
  – Vomiting
  – Salivating
  – Coughing
  – Sneezing
• Cranial nerves
  – allow medulla to control sensations from the head, muscle movements in the head, and parasympathetic outputs
• Lies on each side of the medulla
• Latin for “bridge”
  – Axons from each half of the brain cross to the opposite side of the spinal cord (the left hemisphere controls the muscles of the right side of the body and vice versa).
• Contains parts of the reticular formation
  – Important for attention and arousal
Cerebellum

- Many neurons
- Motor movement, balance and coordination
- Shifting attention between auditory and visual stimuli etc.
Midbrain

• Consists of the:
  – Tectum: “roof” of the midbrain
  – Superior colliculus and inferior colliculus: process sensory information
  – Tegmentum: contains nuclei for cranial nerves and part of the reticular formation
  – Substantia nigra: gives rise to the dopamine-containing pathway facilitating readiness for movement
Animal Research Ethics

1. A UBC researcher submits a new scientific proposal to a funding agency. An independent expert panel reviews the proposal and recommends funding only if the research will make a significant contribution to scientific knowledge.  

2. UBC’s Animal Care Committee reviews all aspects of the project. If approved, a compliance certificate is issued that expires in four years and must be reviewed annually.  

3. The researcher must pass mandatory training in animal handling protocols to ensure that health precautions will be followed for all research staff and animals.  

4. Animal care staff help to refine procedures, train personnel and care for the animals. An independent veterinarian monitors the study to ensure regulations are obeyed.  

5. The Animal Care Committee reviews the project annually. Every four years, the researcher must submit a new proposal to the Committee to continue the research.  

from: http://www.animalresearch.ubc.ca/
Animal Care Committee

- All proposed studies are rigorously reviewed, revised, and then re-reviewed for proper care prior to study starting

- Members serve for 2-8 years; ensures a rotation

- The committee consists of:
  - UBC faculty members
  - veterinarians
  - UBC representative who has never been directly involved in animal research
  - individual from outside UBC who has never been directly involved in animal research
  - individual from animal facility management
  - student (graduate or undergraduate)
Training

• All personnel who work with animals, including Principal Investigators, must have appropriate training

• All personnel must take the courses relevant to their work

from: http://www.ors.ubc.ca/contents/animal-care-faq
• over 90% rodents (mice, rats) and fish
  • increasing use of zebrafish and *Drosophila* (fruit flies)

• the majority of studies (nearly 70%) involve no or minor/short-term discomfort
  • for example: observations of wild animals; tagging or radio-tracking wild animals; short-term restraint for physical examination; blood sampling; a subcutaneous implant or injection; minor surgery
  • proper anesthesia and analgesia (pain control) during and after procedures is required, as appropriate
Possible viewpoints

• Animal research is always acceptable

• Animal research is always unacceptable

• Animal research is acceptable if and only if:
  • discomfort and stress are minimized
  • there are benefits to humans and animals
  • these benefits could not be obtained via other methods (computer models, cell cultures, etc)
The Three Rs

1. Reduction
2. Refinement
3. Replacement
1. Reduction

We are a nonprofit publisher and advocacy organization. Our mission is to accelerate progress in science and medicine by leading a transformation in research communication. Everything that we publish is open-access - freely available online for anyone to use. Sharing research encourages progress, from protecting the biodiversity of our planet to finding more effective treatments for diseases such as cancer.
2. Refinement
3. Replacement

http://www.ted.com/talks/henry_markram_supercomputing_the_brain_s_secrets.html
## Estimates of numbers of animals used annually in the US

<table>
<thead>
<tr>
<th>Type of use</th>
<th>Number used (millions)</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>6,086</td>
<td>96.5 %</td>
</tr>
<tr>
<td>Hunting</td>
<td>165</td>
<td>2.6 %</td>
</tr>
<tr>
<td>Killed in pounds/shelters</td>
<td>27</td>
<td>0.4 %</td>
</tr>
<tr>
<td>Research and teaching</td>
<td>20</td>
<td>0.3 %</td>
</tr>
<tr>
<td>Fur garments</td>
<td>11</td>
<td>0.2 %</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6309</strong></td>
<td><strong>100 %</strong></td>
</tr>
</tbody>
</table>

from Nicoll and Russell, 1990
• BrainFacts.org: http://www.brainfacts.org/about-neuroscience/animals-in-research/

• UBC
  • http://www.animalresearch.ubc.ca/
  • http://www.animalresearch.ubc.ca/faq.html

• Canadian Council on Animal Care (CCAC): www.ccac.ca

• American Physiological Society:
  • http://www.animalresearchcures.org/index.html

• Understanding Animal Research:
  • http://www.understandinganimalresearch.org.uk
  • http://www.understandinganimalresearch.org.uk/latest_news/news/show/321/new_video_why_do_we_use_animals_in_research

• University College London website
  • http://www.ucl.ac.uk/animal-research