# COGS 1: Spring 2019

## Section B, Week 3

<table>
<thead>
<tr>
<th>Name</th>
<th>Email</th>
<th>Day</th>
<th>Time</th>
<th>Location</th>
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<tbody>
<tr>
<td>Professor Boyle</td>
<td><a href="mailto:mboyle@ucsd.edu">mboyle@ucsd.edu</a></td>
<td>Friday</td>
<td>2-4 pm</td>
<td>CSB 130</td>
</tr>
<tr>
<td>Lauren</td>
<td><a href="mailto:lcurley@ucsd.edu">lcurley@ucsd.edu</a></td>
<td>Tuesday</td>
<td>10-11am</td>
<td>CSB 225</td>
</tr>
<tr>
<td>Lexi D.</td>
<td><a href="mailto:dalenko@ucsd.edu">dalenko@ucsd.edu</a></td>
<td>Tuesday</td>
<td>12:30-1:45 pm</td>
<td>Sun God Lounge</td>
</tr>
<tr>
<td>Elena</td>
<td><a href="mailto:edreisba@ucsd.edu">edreisba@ucsd.edu</a></td>
<td>Thursday</td>
<td>1-2 pm</td>
<td>CSB 114</td>
</tr>
<tr>
<td>Adrian</td>
<td><a href="mailto:ajm033@ucsd.edu">ajm033@ucsd.edu</a></td>
<td>Wednesday</td>
<td>5-6 pm</td>
<td>CSB 114</td>
</tr>
<tr>
<td>Audrey</td>
<td><a href="mailto:aberardi@ucsd.edu">aberardi@ucsd.edu</a></td>
<td>Tuesday</td>
<td>4-5 pm</td>
<td>CSB 114</td>
</tr>
<tr>
<td>Devansh</td>
<td><a href="mailto:d4agarwa@ucsd.edu">d4agarwa@ucsd.edu</a></td>
<td>Monday</td>
<td>4-5 pm</td>
<td>CSB 114</td>
</tr>
<tr>
<td>Lori</td>
<td><a href="mailto:rol044@ucsd.edu">rol044@ucsd.edu</a></td>
<td>Monday</td>
<td>10-11 am</td>
<td>CSB 114</td>
</tr>
<tr>
<td>Lexi F.</td>
<td><a href="mailto:adfrankl@ucsd.edu">adfrankl@ucsd.edu</a></td>
<td>Thursday</td>
<td>4-5 pm</td>
<td>CSB 114</td>
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Important Information

● Review Questions
  ○ Available at the end of every week on Saturday
  ○ Use these to guide your understanding of lecture and readings

● Extra Credit
  ○ EC quizzes on readings on TritonEd
    • This week’s quiz is based on Reading for Dr. Rangel
    • Opens Wed 4pm and closes Thu 10am before lecture

● Section Slides
  ○ Posted after the end of the last section on Friday
Last Week’s Topics

- Lecture 3 | Dr. Coulson: Lateralization of Function
- Lecture 4 | Dr. Ellis: From Genetics to Data Science
Lecture 3

Lateralization of Function

Dr. Coulson
1. What does “lateralization” of function mean?
   a. Can you think of different examples from lecture and the reading?
2. What are the main function of the four lobes of the brain?
   a. Are any of these function lateralized?
3. What are the language centers of the brain?
   a. Where are they?
4. From the lecture and your reading--identify the:
   Corpus callosum, Broca’s area, Wernicke’s area, the four lobes
5. What does the Wada test establish? What is it used for? How does it work?

6. What are the differences between Broca’s aphasia and Wernicke’s aphasia?
   a. In lesion areas?
   b. In impairment of language production and/or comprehension?
   c. What about conduction aphasia?

7. What is the simplified Wernicke-Geschwind model of different aphasia?
   a. Are there ways in which the model is simplistic
8. What are the major sulci that divide the different lobes?

9. Where are the primary motor & primary somatosensory cortices located in the brain?

10. What is the homunculus?

11. How do the right and left hemispheres differ and how do they communicate?

12. What is the relationship between hand and hemisphere dominance?

13. What are Brodmann's areas (you don’t need to know the different ones, just know the basics of what they are.)
14. **What is meant by the “average brain is skewed”?**

15. **What are some anatomical differences between the hemispheres?**

16. **What are some functional differences between the hemispheres?**

17. **Identify important regions of the brain that are vulnerable to damage when undergoing brain surgery.**
   a. **Why would someone being undergoing this procedure in the first place?**
   b. **How are these regions mapped out?**

18. **Provide examples of when brain function was altered but enabled localization of function.**
19. Be able to describe anomia and aphasia.

20. What is the purpose of electrically stimulating Neil’s cortex while he names off the objects on each slide?

21. What was significant about the planum temporale?
   a. Where is it located?
   b. How does it differ across both hemispheres?
1. What does lateralization of function mean? Examples?

Definition: The tendency of a hemisphere to be more dominant in/integral to the performance of a certain process

For example:

Left side
- Language
- Cause & effect reasoning
- Schema
- Visual search task
- Local-level visual stimulus processing

Right side
- Face
- Emotion
- Visuomotor task
- Global-level visual stimulus processing
2. Know the major functions of the four lobes.
2. Know the major functions of the four lobes.
3. What are the language centers of the brain? Where are they?
4. What is Corpus Callosum? Where is it?
5. What is the Wada Test? What’s the purpose of it?
6. What are the differences between Broca’s aphasia and Wernicke’s aphasia?

a. Lesion area?

- Broca’s Aphasia
  ○ Frontal Lobe
- Wernicke’s Aphasia
  ○ Temporal Lobe
6. What are the differences between Broca’s aphasia and Wernicke’s aphasia?

B. Impairment?

- Broca’s Aphasia:
  ○ Production
- Wernicke’s Aphasia
  ○ Comprehension
6. What are the differences between Broca’s aphasia and Wernicke’s aphasia?

C. Conduction aphasia?

- Capable of understanding what they are hearing
- But fail to encode phonological information for production
- Caused by damage to Arcuate Fasiculus
7. What is the simplified Wernicke-Geschwind model of different aphasia? Are there ways in which the model is simplistic?
8. What are the major sulci that divide the different lobes?
9. Where are the primary motor & primary somatosensory cortices located in the brain?
10. What does the word ‘homunculus’ mean? What are motor and somatosensory homunculi?
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12. What is the relationship between hand and hemisphere dominance?

Contralateral Processing: The left side of the forebrain mostly represents the right side of the body and the right side of the brain represents mostly the left side of the body.
13. What are Brodmann’s Areas?

A patch of cortex that is cytoarchitectonically distinct from its neighbors. In other words, they differentiate brain areas with respect to the arrangement of their cells.
13. What are Brodmann’s Areas?
13. What are Brodmann’s Areas?
14. What is meant by the “average brain is skewed”?

Asymmetric in volume, function of the two hemispheres.
15 & 16. What are the general differences between hemispheres? (also Q11)
17. Identify important regions of the brain that are vulnerable to damage when undergoing brain surgery.

a. Why would someone being undergoing this procedure in the first place?

b. How are these regions mapped out?

Language area

a. Patients with epilepsy, need brain surgery to remove certain part of the brain

b. Recording the electrical activity from the surface of the brain
18. Provide examples of when brain function was altered but enabled localization of function.

- **Language**
- Compare with the example of car
- Identify the language area through brain lesions
19. Be able to describe anomia and aphasia.

- Anomia: the inability to utter the name after successfully speaking the preamble. (“find the right name”)

- Aphasia: loss of ability to understand or express speech, caused by brain damage.
19. Be able to describe anomia and aphasia.

Types of Aphasia

Fluent?
Is speech fluent?

Comprehends?
Can you comprehend spoken messages?

Repeats?
Can the person repeat words or phrases?

Global aphasia  Mixed transcortical aphasia  Broca's aphasia  Transcortical motor aphasia  Wernicke's aphasia  Transcortical sensory aphasia  Conduction aphasia  Anomic aphasia

www.aphasia.org
20. What is the purpose of electrically stimulating Neil’s cortex while he names off the objects on each slide?

- Localize functions to tiny areas
- “Naming site”
- Do we have an “elephant site”?

(A) In cortical mapping studies of many patients, stimulation of these sites interfered with speech production.
21. What was significant about the planum temporale?

a. Where is it located?

b. How does it differ across both hemispheres?

A. A region of the brain that extends through both hemispheres; in the temporal lobe

B. The planum temporale is larger in the left hemisphere

All Ques.
Lecture 4
From Genetics to Data Science
Dr. Ellis
1. Who set the framework for genetics?
2. What is the basic structure of DNA and RNA?
3. What are the functions of each?
4. What is GWAS? What does it stand for and what does it measure?
5. Understand the central dogma of genetics.
6. What is the epigenome?
7. What is DNA methylation?
   a. How is it studied?
   b. How does it affect RNA transcription and gene expression?
8. What differences in DNA and glial cells are observed in individuals with autism?

9. What is Recount 2? How does it facilitate biological studies?

10. Can we use expression data to predict tissue?

11. What is CBDS?
   a. Who does it target?

12. What factors influence genetics research? What are some variables that must be accounted for?
13. What is polygenic inheritance? How does this affect the risk of diseases like diabetes?

14. What are the applications of GWAS? Give an example of its applied analysis.

15. What are some limitations of such a kind of study?

16. What are SNPs and how are they utilized in GWAS?

17. How did GWAS seek to find the relationship between one’s genes and their educational attainment?

18. What is the relationship between sample size and the ability of GWAS to detect correlation?

19. Identify the potential misuse of genetic prediction.
1. Who set the framework for genetics?

- Gregor Mendel: Father of Genetics
- James Watson, Francis Crick, Maurice Wilkins, and Rosalind Franklin: Structure of DNA
2. What is the basic structure of DNA and RNA?
3. What are the functions of each?

<table>
<thead>
<tr>
<th>Feature</th>
<th>DNA</th>
<th>RNA</th>
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<tbody>
<tr>
<td>Function</td>
<td>Holds genetic information</td>
<td>Transcribes and regulates the genetic information</td>
</tr>
<tr>
<td>Strandedness</td>
<td>Double stranded</td>
<td>Single stranded</td>
</tr>
<tr>
<td>Nucleotides</td>
<td>A, T, C and G</td>
<td>A, U, C and G</td>
</tr>
<tr>
<td>Sugar</td>
<td>Deoxyribose</td>
<td>Ribose</td>
</tr>
<tr>
<td>Size</td>
<td>Large polymers</td>
<td>Variable in size but smaller than potential length of DNA polymers</td>
</tr>
<tr>
<td>Stability</td>
<td>Stable</td>
<td>Unstable</td>
</tr>
<tr>
<td>Location in the cell</td>
<td>Nucleus (a very small amount in mitochondria)</td>
<td>Moves from nucleus (specifically the nucleolus) to cytoplasm/ribosomes</td>
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4. What is GWAS? What does it stand for and what does it measure?
5. Understand the central dogma of genetics.

- DNA replication
- Transcription
- RNA replication
- Translation
- Protein formation

Two copies of DNA -> many transcripts -> many proteins

- DNA: blueprint, 2 copies/cell, gene, 20,000 unique functional units
- RNA: messenger, varies ~360,000, transcript, ~100,000
- Proteins: carry out cellular functions, varies ~10^{10}, proteins (metabolites, hormones, etc.), ~100,000
6. What is the epigenome?

- Set of chemical modifications to the DNA and DNA-associated proteins in the cell, which alter gene expression, and are heritable.
- Example: DNA Methylation
7. What is DNA methylation? How is it studied? How does it affect RNA transcription and gene expression?

DNA methylation is most often studied at CpG dinucleotides.
8. What differences in DNA and glial cells are observed in individuals with autism?

I. Autism Background
II. Transcriptome Analyses
   A. Microglia playing a role in the autistic brain
   B. RNA levels show similar patterns across conditions
III. Epigenome of the Autistic Brain
   A. CpG methylation does not differ
   B. Increased global nonCpG methylation
9. What is Recount 2? How does it facilitate biological studies?

[Diagram showing expression data for ~70,000 human samples]

Answer meaningful questions about human biology and expression.
10. Can we use expression data to predict tissue?

- Previously we used data from GTEx to predict phenotype of TCGA data and SRA...

Prediction is more accurate in healthy tissue.
10. Can we use expression data to predict tissue?

- Decompose the tissue types we have...

A sample reported to be Intestine is predicted to be Colon. That makes good sense.
10. Can we use expression data to predict tissue?

Tissue prediction is largely accurate across recount2

- Tissue can be accurately predicted from expression data.
- Discordant predictions are often made to biologically similar tissues.
- Sometimes, predictions are inaccurate.
11. What is CBDS? Who does it target?

Chromebook Data Science (CBDS)

- Find a partner organization
- Collaboratively develop course content
- Develop new technology as needed
- Design in-person tutoring program
- Launch program, teach the stuff & get learners jobs
12. What factors influence genetics research?

a. What are some variables that must be accounted for?

Phenotypic Differences:
- Sex
- Age
- Tissue types
- Race
13. What is polygenic inheritance? How does this affect the risk of diseases like diabetes?

- **Polygenic inheritance** occurs when one characteristic is controlled by two or more genes.
- There are hundreds of locations in the genome that influence diabetes.
GWAS has two main applications in science:

1. Understand the underlying biological architecture of disease and human variation.
2. Predicting the risk of developing conditions like heart disease and diabetes, from a very early age or even before birth.

“Manhattan plots” correlate genes to a trait or illness

Source: Nature Genetics
15. What are some limitations of such a kind of study?

- Predictive ability of these tests is quickly hitting a ceiling and will not necessarily be useful for most individuals seeking to understand their genetic fate.
- Predictions can also be wildly misinterpreted, leading to genetic astrology.
- There’s another huge limitation to most GWAS studies — they’re only done on white Europeans.
16. What are SNPs and how are they utilized in GWAS?

- Each SNP represents a difference in a single DNA building block, called a nucleotide.
- For example, a SNP may replace the nucleotide cytosine (C) with the nucleotide thymine (T) in a certain stretch of DNA.
17. How did GWAS seek to find the relationship between one’s genes and their educational attainment?

- The genes flagged by GWAS on height tend to relate to the skeletal system; particularly active in the growth plate regions of bones, and point to genes that are involved in the manufacture of connective tissues like collagen.
- The ones associated with educational attainment were clustered in regions having to do with the central nervous system; related with the development of our minds.

Manhattan Plot for GWAS of EduYears

Mean $\chi^2 = 2.53$

$P = 5 \times 10^{-8}$
18. What is the relationship between sample size and the ability of GWAS to detect correlation?

- As GWAS sample sizes grow, so does the ability to find correlations.
- Bigger the sample size, the more genetic markers will be identified, and the more ways we can identify the influence of genetics on our lives.
19. Identify the potential misuse of genetic prediction.

- Predictive tests of traits like intelligence are like “genetic astrology,” and are said to be a waste of money.
- GWASs, at best, provide an incomplete picture from which to draw predictions.
- Polygenic scores of certain characters are an approximation.
Quiz Time!

- No talking, signaling, or communicating of any kind.
- Put away your books, notes, computers, phones, etc.
- Pen or pencil is okay (just make sure it’s a black pen and you press hard with a pencil).
- Write your name in the “Name” box, write and circle in your PID, and sign the academic integrity agreement.
- Bubble in this section
- Please have your student ID out when you turn in your quiz!
Write and circle in your PID

Write down your name here

Bubble in the current section

Sign and date here

Bubble in the answers