# Weekly Schedule

Week 1 “Brain Basics”

- Day 1: Major Structures
- Lobes, amygdala, hippocampus, cerebellum, insular cortex, thalamus, corpus callosum
    - Kirk & Jessica teaching
    - Rosalie coordinating
- Day 2: Neurons
    - Mauricio & Zack teaching
    - Angela coordinating
- Day 3: Nervous Systems and Networks
    - Chris & Rosie teaching
    - Sarah coordinating
- Day 4: **human brains (on Thursday)
    - Students drawing the brain
    - Angela has requested this from Bill
    - Connect all three topics and review
    - Test (in the computer lab)

Week 2 “Communication”

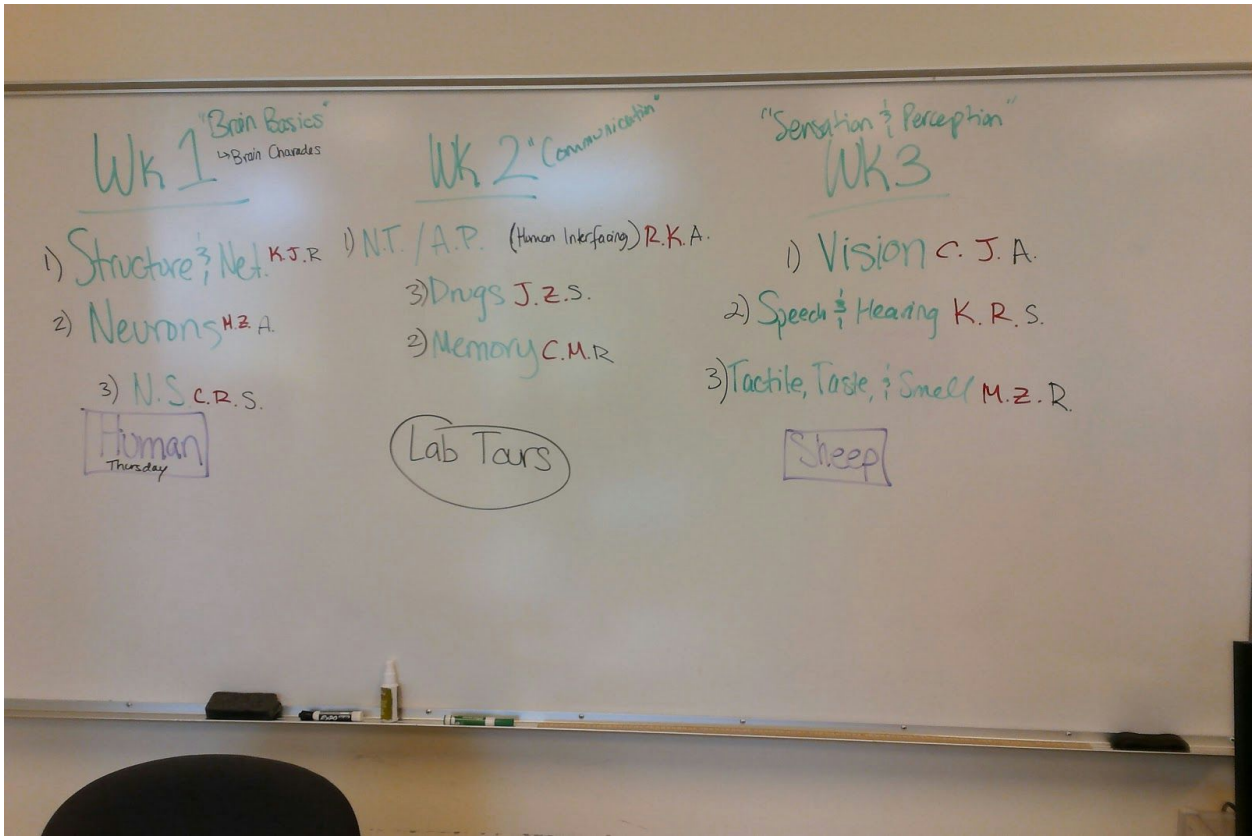
- Day 1: Action Potentials & Neurotransmitters (human interface game)
    - Rosie & Kirk teaching
    - Angela coordinating
    - Review last week’s material
    - Pre-test in the computer lab (?)
- Day 2: Memory
    - Chris & Mauricio teaching
    - Rosalie coordinating
- Day 3: Drugs
    - Jessica & Zack teaching
    - Sarah coordinating
    - Connect all three topics and review
    - here is a helpful/interesting video from NIDA: https://www.youtube.com/watch?v=SufLpGPauII
- Day 4: **WSU lab tours
    - Assessments (computer lab)

Week 3 “Sensation & Perception”

- Day 1: Vision
    - Chris & Jessica teaching
    - Angela coordinating
    - Review last week’s material
- Day 2: Speech & Hearing
    - Kirk & Rosie teaching
    - Sarah coordinating

- Day 3: Tactile, taste & smell
    - Mauricio & Zack teaching
    - Rosalie coordinating
    - Connect all three topics and review
    - **human brain again
- Day 4: **sheep brains
    - Assessments (computer lab)
    - teachers will need to get a list of brain structures that we have gone over and give it to Megan so that she can put together a dissection guide
    - we should use one of the sheep brains to dissect as a teacher group so that we're familiar with it
        - Megan says there is one here at WSU that she will coordinate us dissecting

- Megan and Michael will float between the three groups (teaching each week) to handle the more technical stuff like the dissections and lab tours
- Each Monday and Thursday we have access to a computer lab
- don't need every teacher present every day, maybe you come the day before you teach as well to assist with the lesson and get familiar with what was taught to help tie it into your lesson
    - maximum occupancy concern



**Resources** for lesson plans/activity ideas, as well as information refreshers:
Crash Course - https://www.youtube.com/channel/UCX6b17PVsYBQ0ip5gyeme-Q
Neuroscience for Kids - https://faculty.washington.edu/chudler/neurok.html
Mysteries of the Brain videos - http://www.nbclearn.com/brain/
NW Noggin summer outreach 2015 - http://nwnoggin.org/get-involved/nw-noggin-summer-outreach-2015/
NW Noggin Resources page - http://nwnoggin.org/resources/
Mouse Party (drugs) - http://learn.genetics.utah.edu/content/addiction/mouse/

# Lesson Plans

Week 1 - Day 1 "Brain structures"

- 1 hour orientation with parents
- what does a scientist look like? Drawing Exercise.
    - capture the perception of the students
- why should they care?
    - at the risk of sounding cheesy, neuroscience is part of everything. Every person has a brain and they all have the same basic functions. Understanding the brain helps you understand who you are and why people do what they do. I personally have found it to be an incredible tool for satisfying my curiosity about the bizarre behaviors humans exhibit - why do we like to eat spicy, fatty, or sugary foods when we know they're not good for us? why do horrible on tests when we studied the material? why is it so hard to pay attention to boring people? why do we form social groups, cliques, create friendships, and fall in love? what makes us afraid? what are "gut feelings" and instincts? is there such a thing as a sixth sense? does everybody else get songs and jingles stuck in their heads too?
    - rising rates of autism, ADHD, depression, stress and psychological disorders. chances are that you will encounter people experiencing these conditions. understanding the mechanisms helps breed empathy and erase the stigma surrounding them.
        - "About 11 percent of school-age children in the United States -- and 19 percent of high-school-age boys -- have been diagnosed with attention-deficit/hyperactivity disorder (ADHD), according to U.S. Centers for Disease Control and Prevention data." (source: http://www.webmd.com/add-adhd/childhood-adhd/news/20130401/one-in-10-us-kids-diagnosed-with-adhd-report)
        - Anxiety disorders are the **most common mental illness in the U.S.**, affecting 40 million adults in the United States age 18 and older, or 18% of the population. (Source: National Institute of Mental Health)
            - It's not uncommon for someone with an anxiety disorder to also suffer from depression or vice versa. Nearly one-half of those diagnosed with depression are also diagnosed with an anxiety disorder.
        - Anxiety and depression in children (Image 3)

- along with the rising prevalence, there will be an increased need for professionals experienced in neuroscience
- possible professional career paths
    - Neuroscience careers: https://faculty.washington.edu/chudler/chjob.html
    - kirk is creating a handout that gives shorter summaries of these psychology careers: http://careersinpsychology.org/psychology-careers
        - ask the students to circle one or two they might be interested in
- **make sure to note that psychological research isn't all about sadness, anxiety and depression. There are the emerging fields of Positive Psychology and the Science of Resiliency that are studying how to make or keep people happy.
- understanding the human condition
    - understanding yourself
        - Have you ever wondered what exactly it is that you are? You pick up a ice cube and you know that it is water molecules that have been slowed down by freezing them so that they form a geometric crystallized structure. Or you look at a leaf under a microscope and you can see that it is just a bunch of plant cells that have formed in an elegant, familiar pattern. But what the heck are you? Human beings are much more complex, MUCH more. But we too are just a bunch of cells stuck together, forming many systems that work together and keep us alive. 37 trillion cells in the average adult body - heart cells, brain cells, liver cells, kidney cells, muscle cells, skin cells, bone cells - and they all started from one cell, one single cell, that contained all the information to produce one whole human being - you. So that's what you are - a complex, interconnected system of systems that are made up of trillions of specialized living cells, feeding off the energy and nutrients in the food you eat, the water in the liquids you drink and the oxygen in the air that you breathe.
        - But let's get more specific, what's the difference between you and a pile of cells that we could grow in a lab? Your cells communicate with one another AND with the outside world. Which is really a remarkable phenomenon if you think about it. Our cells receive information about their surroundings from our senses, and our senses are just the names we have given to a few of the many systems in our bodies. Our senses are made out of nerves which are bundles of neurons (which is the same basic kind of cell as in the brain). Nerves both receive information and send it in chains of neurons to the brain (collectively called our "sensory system") and transmit information from the brain to the muscles that control our movement (called our "motor system"). The "information" I'm talking about is a code of electrical pulses accompanied by the release of small chemicals from one neuron to the next in a chain. This basic process of receiving,

processing, and sending information is the fundamental function of the central nervous system.
        - understanding other people's behavior
        - the variety of human perception
    - question: what function of the brain could you go without
- **what do they already know and what do they want to know?**
- lobes and their functions (image 2)
    - **Emphasize that no lobe works in isolation or just has one job, the roles are all distributed
    - Occipital - Vision
        - think optometrist
        - Jessica
    - Parietal - Sensation and Spatial Orientation
        - Kirk
        - This is where information such as taste, temperature and touch are *integrated*, or processed. Humans would not be able to to feel sensations of touch, if the parietal lobe was damaged. (source: http://brainmadesimple.com/parietal-lobe.html)
        - Sensory Homunculus
    - Frontal - Executive Functions (reasoning, decision-making), personality
        - Jessica
    - Temporal - Auditory and Object Recognition, some role in emotion and memory
        - Kirk teaching
        - This lobe mainly revolves around hearing and selective listening. It receives sensory information such as sounds and speech from the ears. It is also key to being able to *comprehend,* or understand meaningful speech.
    - Insular - Emotion and Memory and Enteric system (visceral organs)
        - __look up how many neurons are in the enteric system
        - Jessica
    - Cerebellum - balance and coordination
        - Kirk
        - Responsible for balance and coordination of muscles and the body.
        - It is important for being able to perform everyday *voluntary* (done with purpose and intent) tasks such as walking and writing. It is also essential to being able to stay balanced and upright.

- Cingulate Cortex - (anterior - conflict monitoring and posterior - self-referential processing)
    - Kirk
    - It is an integral part of the limbic system, which is involved with emotion formation and processing,[1] learning,[2]and memory.
    - highly influential in linking behavioral outcomes to motivation (e.g. a certain action induced a positive emotional response, which results in learning).
        - Anterior: The ACC is involved in error and conflict detection processes.
        - Posterior: forms a central node in the default mode network of the brain. has been implicated as a neural substrate for human awareness in numerous studies of both the anesthesized and vegetative (coma) state. Imaging studies indicate a prominent role for the posterior cingulate cortex in pain and episodic memory retrieval.[2] The posterior cingulate cortex has been linked by lesion studies to spatial memory, configural learning, and maintenance of discriminative avoidance learning.In humans, the default mode network has been hypothesized to generate spontaneous thoughts during mind-wandering and may relate to creativity.
        - Connection of A and P: The posterior cingulate gyrus discerns emotional and self-relevant information; this interacts with both the anterior cingulate gyrus, which integrates emotional information with cognition, and the medial prefrontal cortex, which allows for self-reflection and the regulation of emotion and arousal.
- Amygdala - fear
    - Jessica
- Corpus callosum
    - Kirk
    - The Corpus Callosum is the part of the mind that allows communication between the two hemispheres of the brain.
    - Anecdote - sometimes CC is severed partially or fully to offset severe seizures and leads to strange side-effects. In one case, a man who underwent the procedure noticed that his left hand would unconsciously be unbuttoning his shirt while he was actively buttoning it up with his other hand.
- exercises:

- brain area charades
- brain-tingling questions:
    - how do blind people dream?
    - have you ever heard of zombie ants?
    -
- photo transfer picture of brain onto printed photo of each student
- candy models
- comic book about what each lobe does, what characters with a superhuman lobe would be like

-brainstem
-spinal cord

    - Introduction ideas
        - What got each of us into neuroscience
        - seated name game
            - each person describes themselves with an adjective that begins with the first letter of their name
            - useful mnemonic, gives them a chance to be creative but comfortable
- brief overview of the course and what we'll cover
    - recommendation: we ask the students what they want to learn, make minor/major adjustments to lesson plans to account for their interests
    - recommendation: come up with worksheets or something to accompany what we're teaching
- lab safety (Megan)
- Computer lab - registering the students with the assessment app (15-25 minutes)
- Who is going to be present the first day?
    - Concerned that if everyone is there that it might be intimidating and/or distracting

backup activities

- breaking students into groups (lobes) to create skits for what that part does and then give them a task

Day2: Neurons

- Review lobes - how they connect with networks of neurons
- Right/left hemisphere Corpus callosum
- White matter/ grey
- How we have come to understand the brain.
- Previous conseptions of what our brain does - what it really does
- phrenology brodmann /some history
- http://blogs.scientificamerican.com/brainwaves/know-your-neurons-the-discovery-and-naming-of-the-neuron/
- What different neurons look like and do.

- Electrical/chemical signals.
- Myelination.
- Stem cells
- Brain cell growth.

Day 3: Nervous System and Networks

Materials needed:

-Art supplies for project representing components of nervous system
-Vellum paper for Juliette
-Projector on Smartboard to show pictures
-Large piece of plexiglass (Chris will bring)
-Beanbags or other soft plush objects
-Copies of picture dictionaries
-3d Skeleton if possible?
-1 ruler for each partner (7 total)

Timing:
Networks + Skit (30-35 min total)
Nervous System + Activities (55-65 minutes total)
Art Project (25-30 minutes total)

Start with networks
Review the anatomical structures from day 1 and focus on prefrontal cortex, cingulate (anterior and posterior), amygdala, and the parietal lobes (5 minutes)

4 main networks of focus and three main [basic] brain structures involved: (7-10 minutes)

1. Attention Network
    a. PFC
    b. Parietal Lobes
    c. ACC
2. Emotion Regulation Network
    a. PFC
    b. ACC
    c. Amygdala
3. Salience Network
    a. Insular lobe
    b. ACC
    c. Amygdala
4. Default Mode Network
    a. PFC

b. PCC
c. Parietal lobes
d. [hippocampus]<---should we keep it at 3 each?

Why do networks matter? (7 minutes)

- Although we tend to learn about the brain in isolated parts, it's crucial to understand that the brain works as a whole integrated system. The complex functions of your mind and body are possible because different specialized areas of your brain integrate with others, forming strong connections that allow for dynamic processes to run smoothly.
- If all we cared about were the separate parts of the brain, we wouldn't even come close to understanding the full functionality of what our brains are capable of. It's like when you work with a group of people. When you learn to use your strengths to work together the best you can, you're capable of exponentially more things that you would be by yourself.
- As Michael said, if we're not learning about networks our brain structures are involved in and how those apply to our lived experience, then who cares?? :) `
- Studying networks in the brain is in line with the current movement in science as a whole toward a more systems based approach; if you're going to start studying the brain, this is the direction you've got to go

Jessica's Idea (10-12 minutes): Putting together skits with the different brain areas and their roles in networks

- Do you mean splitting up the students between different brain areas (such as PFC, Amygdala, Parietal, etc) and having them act out the function of each area? For example, you could give the students a problem to "solve" and have them try to approach the problem from their designated roles? If so, I like this :) - Chris

Nervous System:

Students will each receive a blank "picture dictionary" template (boxes). As we go through explaining the material, students will take a moment to pause and draw in a picture of the material we are covering. For example, in one box, students will label "CNS" and then draw a picture of the brain and spinal cord together. (I can create these templates and make copies for students - Chris)

Explain CNS (Rosie) (7-10 minutes)

-Components of CNS - Brain/Spinal Cord/Brainstem

-While Rosie is explaining the components of the CNS, Juliette will be drawing out the components of the CNS in real-time on large vellum paper for an extra visual layer for the students.

-I wanted to ask Megan if it would be possible for us to have a 3d model skeleton to refer to when we're talking about the CNS so the students can see an actual size representation of bones etc. (5 minutes if possible)

-For a quick "hands on" layer, it might be nice also to have the students run their hands along their skull and down their back tracing the spinal cords. Most students probably do not realize how long the spinal column goes down the back. (3 minutes)

-PNS (Sarah & Chris) - Rosie, feel free to jump in throughout all of this!

-Sarah, since you are more of the expert here, it might be good for you to orally explain the components of the PNS one at a time, making sure that we stop.

-While you are doing that, I can draw out the tree diagram on the board and chime in. As we go through each of these components of the nervous system, I think it would be good for the students to take a moment to draw out a picture representation of each one so that they will remember it better. I can jump in to help them do this part. I can also lead the activities.

-Juliette can continue her vellum drawing as we go through the material

-Somatic Nervous System- voluntary movements (5 minutes)

Picture on smart board - (https://upload.wikimedia.org/wikipedia/commons/thumb/5/5b/Nervous_system_diagram-en.svg/2000px-Nervous_system_diagram-en.svg.png)

-Spinal nerves

-Cranial nerves

-Association nerves

- Quick activity - Flex your muscles, move all of your fingers individually. Have you ever stopped to think how you are able to have such precise control? (3 minutes)

-Quick activity (if time) grabbing ruler from partner

-Students draw a quick sketch of Somatic Nervous System in picture dictionary (6 minutes)

-Autonomic Nervous System- involuntary movements (5 minutes)

-Internal organs

-I think it would be cool to show a picture like this on the smart board(https://upload.wikimedia.org/wikipedia/commons/f/f3/1503_Connections_of_the_Parasympathetic_Nervous_System.jpg)

-Chris talk about reflex nerve connections circumventing your brain's control

-Quick class activity - have each student cross their legs and swing their legs away from desk. Noggin people go around to each person and do a quick knee reflex test. For any people whose knees did not reflex, if they want to volunteer, Chris can show a few tricks to hopefully get it to reflex :) (5-10 minutes)

-Students draw quick picture of autonomic nervous system in picture dictionaries. (4 minutes)

-Parasympathetic Division- Rest or Digest (4 minutes)

-Digestion

-Clean out the waste when you sleep

-Students draw quick picture

-Sympathetic Division- Flight or Flight , Fear

-

(Picture: https://upload.wikimedia.org/wikipedia/commons/7/77/Gray838.png)

(10-12 minutes) - Activity - Ask for “brave” volunteers. Have students line up behind large plexiglass (Chris will bring). Let them know exactly what will happen: in the next 10 seconds, I will throw a beanbag at them. Their goal is to try to use the power of their thinking to prevent themselves from flinching. Then throw bean bags. Noggin people will monitor each volunteer to see if they flinched or not. More students will want to do it after the first group.

Cumulative Art Project - Day 3 (30 minutes approx)

-Each student will choose (or be assigned) a component of the PNS or CNS that we discussed thus far.

-Their goal will be to represent this component visually using any of the art supplies. This would be 2-D, or 3-D.

-First, each person must "ask an expert," meaning go around the room to Noggins and ask them for help identifying the function of their component.

-Then, they complete their visual representation and write or tell a bit about what it does and how it connects to the rest of the nervous system.

-If there's time, students could show their finished projects and explain how they came up with the idea, etc.

-If time, it would be awesome for the students to gather their finished projects together so that we could form either on a table or on the wall some kind of connected structure. Maybe we could even connect the components together with yarn or string.

Image 1

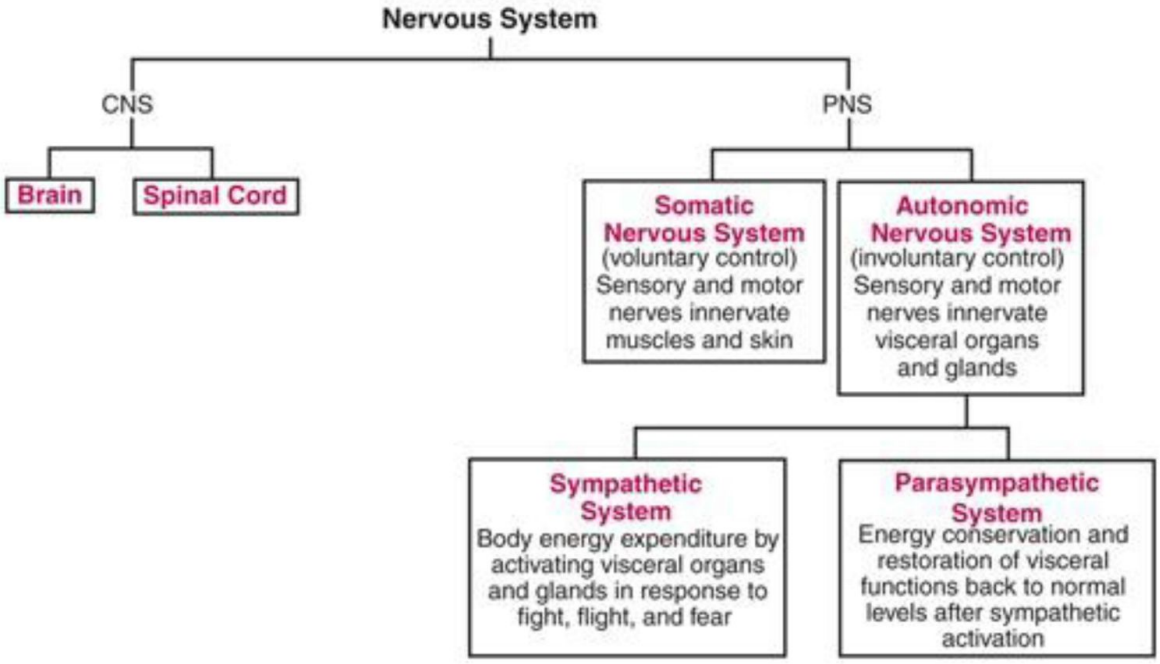

Nervous System
CNS
PNS
Brain
Spinal Cord
Somatic Nervous System
(voluntary control)
Sensory and motor nerves innervate muscles and skin
Autonomic Nervous System
(involuntary control)
Sensory and motor nerves innervate visceral organs and glands
Sympathetic System
Body energy expenditure by activating visceral organs and glands in response to fight, flight, and fear
Parasympathetic System
Energy conservation and restoration of visceral functions back to normal levels after sympathetic activation

Image 2

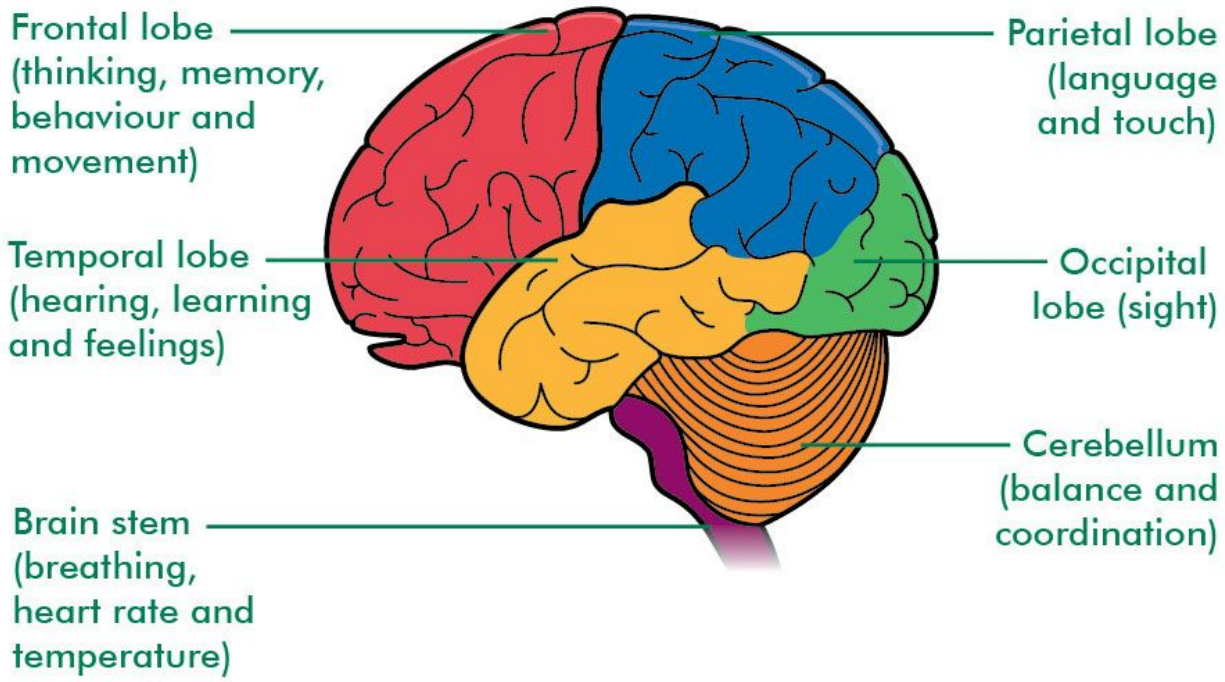
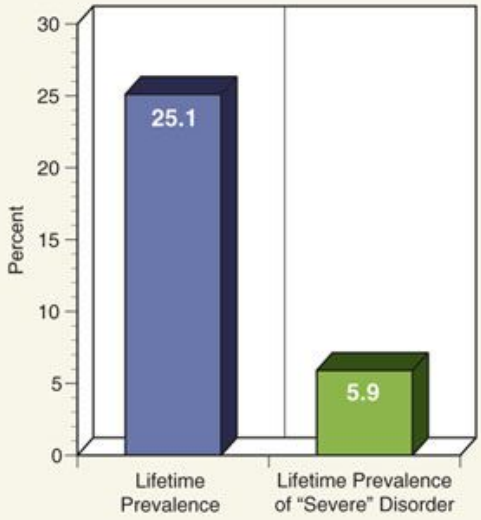

Frontal lobe (thinking, memory, behaviour and movement)
Parietal lobe (language and touch)
Temporal lobe (hearing, learning and feelings)
Occipital lobe (sight)
Cerebellum (balance and coordination)
Brain stem (breathing, heart rate and temperature)

Image 3

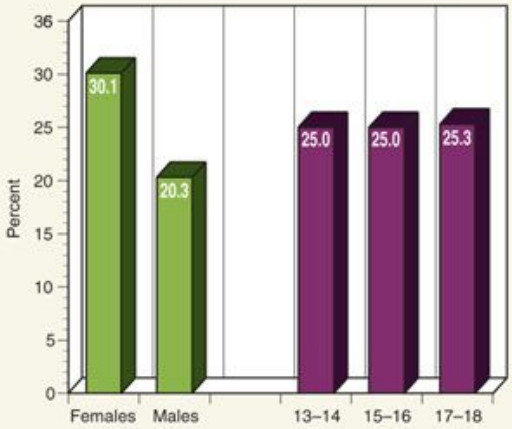
## Lifetime Prevalence of 13 to 18 year olds

- **Lifetime Prevalence:** 25.1% of 13 to 18 year olds
- **Lifetime Prevalence of "Severe" Disorder:** 5.9% of 13 to 18 year olds have "severe" anxiety disorder




## Demographics (for lifetime prevalence)

- **Sex:** Statistically different
- **Age:** Not statistically different




- **Race:** Statistically significant differences were found between non-Hispanic whites and other races

[1]Merikangas KR, He J, Burstein M, Swanson SA, Avenevoli S, Cui L, Benjet C, Georgiades K, Swendsen J. *Lifetime prevalence of mental disorders in U.S. Adolescents.* Under review.

Week 2 - Day 1 “Neurotransmitters and Action Potentials”

- Action Potentials
    - outside activity
        - assign the following structures to the students: dendrites, ion channels, potassium, sodium, different neurotransmitters, receptors
        - have them act out a single AP
- Neurotransmitters
    - introduce the major NTs and what they do so they’re familiar for the drug section
- Reward / pleasure /pain

Week 3 - Day 1 “Speech and Hearing”

- Hearing and sound (Kirk)
    - Kirk begins with playing a short riff on his acoustic guitar
        - Explains the basic principle of sound waves
            - the string is plucked, based on its diameter and length, it will vibrate back and forth a certain number of times each second
            - This vibration shoves the surrounding air molecules together, like pushing a bunch of people standing closely in line for a theme park ride (compression and rarefaction)
                - https://www.youtube.com/watch?v=aPswnDcteS4
                -
            - This pattern of pressure travels through the air to your ear
        - Explains the mechanics of the ear (maybe ask Sarah to give some in-depth descriptions here)
            - pressure wave meets and moves the ear drum, moves the ossicles, which moves the oval window of the cochlea in and out, creating waves in the liquid of the cochlea
            - The pressure inside the cochlea causes the tectorial membrane to mash down on the stereocilia and open the channels that trigger the action potential
            - The cochlea is laid out by frequency, with the higher frequencies interpreted at the bottom and lower at the tip (explain the physics behind this)
            - So the information coming into the auditory nerve is already organized by frequency. But what does this map of frequencies coming into the brain look like?
                - [Opportunity to talk about Cochlear implants here]
    - recording student voices, showing and modifying the spectrograms
        - Using Audacity and WaveSurfer
            - Audacity will show the frequencies and amplitudes of the recorded speech sounds over time and allow us to modify it to understand how sound changes

- WaveSurfer will more accurately show the bands of speech sounds so I can explain formants
    - Formants are bands of overtones. An overtone is another sound wave that is a multiple of the base wave, the strongest wave.
    - [examples]
    - Formants are how computers can recognize speech so easily.
        - [Examples of Siri, Google Now, Microsoft Cortana, etc.]
- Speech (Rosie)
    -