



***The Chemical Human: Exploring the Effects of Psychopharmacology on the Human Condition***

by Morgan A Andrews, 2017 CTI Fellow  
William A. Hough High School

This curriculum unit is recommended for:  
AP Psychology Grades 10-12

**Keywords:** Psychology, Chemistry, Drug Interactions, Biomedical Therapies

**Teaching Standards:** See [Appendix 1](#) for teaching standards addressed in this unit.

**Synopsis:** This curriculum unit contains information on the ever confusing and complex world of drugs and how they interact within the body. Students will apply psychological principles to drug discovery, development and application. In a society that maintains a “bigger, better faster” mentality, students will be charged with the task of learning how to think critically about the manner in which they choose to respond to adverse situations. The goal of the unit is to educate students on how chemicals interact in the body- specifically within the brain- how those drugs are discovered and the manner in which those drugs are acquired. Students will research common mental health issues related to the high school experience as well as the drugs commonly used and misused by adolescents. The curriculum unit offers a platform for students to create public awareness around the school and community about the importance of mental health and the dangers and effects of drug misuse. Students will also promote a campaign about healthy coping strategies for the teenage plight.

*I plan to teach this unit during the coming year to approximately 80 students in my AP Psychology classes, grades 10-12.*

*I give permission for Charlotte Teachers Institute to publish my curriculum unit in print and online. I understand that I will be credited as the author of my work.*

## Introduction

### Rationale

Our student population is competitive- I've heard stories of cheating, lying, backstabbing and an overall rise-to-the-top-at-all-cost type of attitude amongst students...think Game of Thrones. With that said, these students don't really have much of a choice in their behaviors- especially those who plan to apply to a 4 year university. The students I teach are consistently preoccupied and stressed about getting into a good college, and rightfully so. The admittance rate of some colleges today is scary- in North Carolina, the average admission rate is roughly 50%.<sup>i</sup> I often wonder that if I were applying today would I even get in. Multiple times a week I hear students mention their struggle with anxiety or attention deficit disorders- regardless of an actual diagnosis from a licensed professional. This is somewhat surprising to me given America's shaky relationship with mental health. Some people may be embarrassed by their mental health diagnoses- which is why students' verbal proclamations of their mental state seems like a testament to our society's acceptance of anxiety and attention disorders. It is almost as if it is commonplace- even expected.

More than likely (I don't know for sure) the self-diagnosing may lead students to self-medicate or perhaps students are under the impression that experimenting with medications may reduce their levels of stress or anxiety. Reportedly, over half a million teens admitted taking the drug prescribed to help treat attention disorders, Adderall.<sup>ii</sup> If true, this also means teens are increasingly engaging in the common practice of sharing psychopharmacological drugs to enhance academic performance.

The shared meds I hear about most frequently, via conversations in hallways, are drugs intended to help with attention disorders. Students in my classes reported that they or someone they know has used ADD medication to aid in studying for tests or completing projects. These drugs are relatively new to the scene- in terms of wide-spread availability- and compared to other illicit drugs there isn't much awareness education. I think it's normal for adolescents to have a relatively small scope of the concept of time and probability of consequence. Early in the school year we learn about the anatomy and functions of the brain- the way the brain works and why. Later we discuss the development of the brain and how it might affect personality and decision making. Often my students are surprised to learn that the brain is still developing well into adulthood. It is almost comical to see the wave of understanding hit them when we talk about the impulsive tendencies of young people (as it is the part of the brain that develops last). The difficulty lies in getting them to fully grasp that how they treat their minds now can and will have a direct effect on the brain's ability to function later, as they age. Furthermore, because there are relatively little short-term side-effects for ADD medication students may not consider the long-term effects of the drug.

This particular seminar, *Chemical Interactions in the Body*, sounded like it would be beneficial for me to know more about how medicinal chemistry works. In my content area I get to teach about biomedical therapies, including drugs. I felt my knowledge of this area could use a face-lift so to speak. I needed more information to add to my otherwise limited knowledge about which drugs are used for what disorders. I am fascinated by how our bodies, specifically the

mind, process medications; this is also an area that the kids are interested in. Little did I know that medicinal chemistry would be so enlightening and confusing. During the seminar meetings I learned that the process of a drug's development is tediously complicated. Furthermore, in my own research, finding a drug that targets mental health is mere luck- in fact they call it serendipity.<sup>iii</sup> This led me to the eventual discovery that some of the central nervous drugs, though approved by the Food and Drug Administration, aren't fully understood. It was for this reason, coupled with the increased student curiosity about study drugs that I committed to the seminar. Perhaps furthering my knowledge base could be successful in getting some students to really look at happens within- particularly in a world that is so seemingly focused on the outside.

## Demographics

William Amos Hough high school is located in Cornelius, NC and is a suburban school in the Charlotte Mecklenburg School system. There are close to 2500 students, the majority of which are white, twelve percent black, six percent Hispanic, two percent Asian and four percent classified as other. There is a fifty-fifty split of students are identify as male and female. At Hough, sixteen percent of the students belong to families considered economically disadvantaged. Our students consistently score higher in math and English proficiencies than students at both the district and state levels. Sixty percent of our student population participate in the Advanced Placement program and sixty-eight percent pass at least one AP national exam per year. Each one of our one hundred and twenty teachers are deemed 'highly qualified' by the state and some are considered exceptional by me.<sup>iv</sup>

This curriculum unit is designed for my AP Psychology course and will be taught to eighty-two students. I have two sections which meet every other day for ninety minutes from 7:15-8:45. Statistically speaking, my classroom isn't representational of the Hough student body- there is a significant gap in the female/male ratio wherein females outnumber males 8:1. This classroom statistic does influence what I know about my students and how I structure the class-meaning that gender doesn't influence the topics I cover or the demands and rigor of the class. Additionally, there is no prerequisite to AP Psychology and any student willing, may take the class. I have an equal number of students in the tenth, eleventh and twelfth grades in my class. The curriculum unit does require the students to use knowledge gained in biology and health classes. It is important to note the adolescent ability to retain information from completed courses; many students merely remember talking about certain topics we cover in Psychology. This curriculum unit is multi-tiered and requires all year to cover the information as it pertains to both the specified units designated by the high school curriculum as well as the final student project. For this reason, I suggest a concentrated, thorough focus on areas of study that contain neural communication, drug interactions, social influences and stress responses.

## Unit Goals

This curriculum unit has several themes (research, CNS basics, drug effects, stress endurance, biomedical therapies, and social influence) which will all converge at the end with a student project.

- The first theme will attempt to show the various methods of research and the scientific basis of Psychology.
- The goal for the second theme is to understand how the brain processes information, specifically the mechanics behind neural communication with a focus on activity in the synapsis.
- The third theme, drug effects, requires students to understand how psychoactive drugs affect synaptic activity- addressing the difference between agonists and antagonists.
- Fourthly, students will study the effects of stress on the mind and body and methods of coping.
- In the fifth theme, biomedical therapies, students will explore those methods that use psychopharmacology.
- And last students will explore the influences of group behavior- particularly the competitive culture at Hough- on individual experience.

## Content Research

If you feel like you “can’t even” with chemistry...I understand, truly. My last brush with Chemistry was fifteen years ago when I started a small fire. To be honest, I can’t tell you if it was intentional. In this section I hope to give you a rudimentary breakdown of medicinal chemistry that will aid in teaching this curriculum unit.

What is psychopharmacology?

It might be obvious but I’ll state it anyway...this area of study is the link between psychology and this seminar. Psychopharmacology deals with treating mental disorders with medication. I heard before that we know more about space than we do about the brain (I feel like our understanding of both is infantile), given this information it is understandable why psychopharmacology is a continuously updated field. Talk about your professional development requirements! Each year there are more and more discoveries about genetics and neurology that without constant upkeep one’s knowledge from year to year would become obsolete. These specialists must know the inner workings of pharmacokinetics and pharmacodynamics.<sup>v</sup> I think it’s important to note that psychiatrists are the most qualified psychopharmacologists. In class we discuss the differences between psychologists and psychiatrists and most students don’t understand why I am so emphatic about head meds and who prescribes them. I give them this example...would you go to a general practitioner for surgery? As a disclaimer, and slightly biased perspective, I also tell them that drug therapy works best when given in conjunction with therapy- which the psychiatrist is ill-equipped.

## Drug Discovery

There once was a time when drug discovery worked backwards...researchers would inject animals with diseases then try to cure the disease within the animal. The next step was to isolate and understand which molecule interacted with the diseased target (protein, enzyme or receptor). The current method of drug discovery works by finding a disease or symptom and testing for molecules that effectively bind to the target- this process is called an *assay*. Most labs have a library stocked full of molecules- millions of molecules- to find *potential leads*, or molecules that have the best chance of becoming a drug. Chemists are able to use the information about the relationship of the lead and target to alter the structure of the molecule to increase the strength, or staying power, of the interaction of molecules. It is at this process that companies will patent the best molecules and increase the probability of making money; after all it does take about 2.5 billion dollars to develop a drug from scratch.<sup>vi</sup> I'll take a moment to praise your tenacity for reading about this early stage of drug development. It's necessary to have a basic idea of this process so you can understand a) what goes into making a drug and b) the chances of a drug making it to production. Literally one in a million chances of successful drug development. Anyway, let's jump back in. It isn't just about a successful relationship between a molecule and its target- it is also about the *metabolic breakdown, toxicity and efficacy*. These properties are tested in "pre-clinical" trials, aka animal testing. Prior to becoming an actual drug, the "clinical candidate" must be approved by the FDA as an investigational new drug, or IND, before entering clinical (human) trials; the candidate is safe and effective enough for humans to try. The FDA approves roughly one in eight possible drugs.

Clinical trials have three phases. In phase one the drug candidate is tested on healthy humans who volunteer- these trials are only about safety. The second phase uses patients who have the specific disease/ailment of interest. The second phase is still about safety and also includes the discovery of the effective dosage. The third phase is an extension of the second whereby researchers can study how the would-be drug behaves over a diverse population. If each trial is successful, then the drug company can file for a new drug application or NDA. During the review of the NDA, the drug's patent (money-making) clock is ticking. The patent for the drug protects the intellectual property of the drug company. If the drug is accepted by the FDA the drug company is allowed to put the drug on the market and of course continue to monitor the safety of the drug

Consider the many possible outcomes of these clinical trials: Maybe the drug has too many unintended/unwanted side-effects and is considered unsafe; Or what if the drug doesn't work the way it was intended? This unintended circumstance allows researchers to assess whether or not the drug could be marketable for an altogether different ailment. For example, Viagra was originally in clinical trials to treat cardiovascular disease by lowering blood pressure...researchers found out about the side effect (now purpose) of the drug because patients wouldn't return the samples.<sup>vii</sup> As silly as it sounds this by-mistake-drug-discovery is often the method of finding treatment for mental health disorders.

## Obstacles and Advances of CNS drugs

It's true, the human is a marvel. Medicinally speaking, scientists have a good understanding of how the body reacts to disease and treatment. Drugs are metabolized by enzymes housed in the pancreas and liver-these enzymes work to breakdown a drug for bodily distribution. Typically, a normal drug has a large molecular weight so when drugs are metabolized they will still have an effect. This also reduces the likelihood of a drug making it to the central nervous system because of brain's built-in bouncer. The bouncer, or *blood brain barrier*, helps keep the brain safe from toxic invaders. Molecules have to be small enough to penetrate the brain's protective barrier. The blood brain barrier has three major roles; to protect the brain from foreign substances, protect the brain from biological chemicals within the body and lastly, to keep the brain in a constant states.<sup>viii</sup> We need the BBB- and it's a rather complicated obstacle in CNS discovery. . In order for drugs to make it to the brain chemists must develop binding-abled molecular structures that are small enough to enter the brain yet still be effective. Scientists are still learning how it works and understand molecularly how to bypass the barrier. This BBB is the first layer of developing effective CNS drugs- the second is understanding the maze in the brain that really boggles the world of drug making.

Understanding the brain is one thing- understanding the mind is another. Mental disorders are classified by general symptoms that manifest in individuals. Symptoms can also be experienced differently internally for each individual. This brain and mind paradigm can be confusing for psychologists and scientists alike- especially with regards to drug development. If mental disorders only affected the brain, then maybe it would be easier to find a cure. I mean, if you suffer from diabetes and need insulin the cure is simple (relatively). A person who suffers from Parkinson's lacks dopamine- why can't we just create a dopamine agonist, or drug that increases the neurotransmitter's effects? Mental disorders are complex and though they can have a biological root they can also have an aspect that is rooted in a subjective experience.<sup>ix</sup>

The first step in understanding and developing a biomedical treatment of a mental disorder/disease is to actually understand the biochemical pathway of the disease. There is minimal understanding of mental disorders.<sup>x</sup> Not to mention that many CNS drugs were discovered *serendipitously*. Moreover, CNS drugs aren't worth the risk to most drug companies-meaning the development process would not be profitable compared to the counterparts. Additionally, drugs that target the brain that actually make it to clinical trials have high placebo rates and higher failure rates. Companies that do decide to attempt CNS drug discovery may find that they do have potential leads but efficacy is too low to proceed to any type of trial.<sup>xi</sup> Here's the thing- there is a huge money market for drugs that affect the central nervous system. Already the market for these drugs exceeds 50 billion dollars each year- but it's difficult to get these drugs to market. The top three reasons: the brain is complex and our understanding of it is low; most CNS drugs cause other CNS side effects; the blood brain barrier.<sup>xii</sup> So what are we to do?

There is hope for CNS development. As I mentioned above, the advances in technology are creating more opportunities for breaking down the way a mental disease attacks the brain. Discovering specific strands of diseased genealogy and isolation of said gene could potentially lay the groundwork in directed and purposeful CNS drug development.<sup>xiii</sup> For me, studying DNA sequencing seems as complex as drug discovery. Alas, understanding the genetic pathway

of a mental disorder is providing a better understanding of the mechanics of particular disease. The use of genomic technologies to determine genetic sequencing can be pricey, albeit considerably less than drug discovery, is highly successful. Already, we can assess the genetic pathways of schizophrenia, bipolar disorder and autism.<sup>xiv</sup>

## Adolescent Mental Health

I think there is an innate desire by most teachers to make their students' lives better. Unfortunately, it is not always easy to consider how we affect them- with all the requirements that the job entails and the sheer number of students we are held accountable for- it's easy to overlook the state our students are in. I remember a time when school was a relatively safe place and pressure and judgements weren't constantly being updated on our personal devices. In my personal experience as a teacher, it seems as though there is a strong correlation between exposure to technology and higher levels of anxiety and depression. One in five adolescents have a diagnosable mental disorder.<sup>xv</sup> This is a difficult statistic to digest...out of approximately 80 of my AP students 15 are statistically affected by a mental disorder. Yes, I understand that our country has made leaps and bounds when it comes to accepting the importance of mental health- even so, we must do more than acknowledge the relevance. Some of the most prevalent disorders that affect teens are: anxiety, mood (depression is the leading mental disorder), eating, attention disorders and substance dependencies.<sup>xvi</sup> These disorders are widely known and many of my students know someone who is diagnosed with one or more of these. Interestingly enough, many people seek the care of a general practitioner or family physician- as I stated earlier, these providers are ill-equipped to assess and treat mental disorders effectively. In my own experience, students who are vocal about their diagnoses disclose that they rarely seek additional therapies outside of prescriptions.

I started teaching 12 years ago, in that time there seems to be more acceptance among the youth of certain mental disorders. The stigma is not as harmful as it once was...for teens who suffer from "acceptable" mental disorders like anxiety or attention disorders. I believe the acceptance is the normalizing of these disorders- like, the prominence of a disorder in a community can determine the community's tolerance. Regardless of diagnoses students can understand and relate to anxiety causing stimuli. Furthermore, any teacher can tell you even the best pupil can have problems paying attention the entire class period. When we can empathize we can accept. These are just my own thoughts. In our competitive society people rarely have time for "working it out" the long way- with multiple meetings with therapists. Especially when they can get medication to help with their diagnosis. In fact, adolescents who see a family doctor are more likely to be prescribed medication.<sup>xvii</sup> I believe in medication- especially for those who need it. With that said, I think it's obvious that CNS drugs work in complicated ways and prescriptions and dosages would be better off left with trained psycho-pharmacologists, like psychiatrists.

## The Drug Culture in High School

Regardless of the opinions on whether or not children are being over-diagnosed and/or over-medicated, it should be painstakingly obvious that adolescents are taking drugs. I think there is a parallel between society's drug culture and a high school drug culture. It's true for fashion, language and gadgets- why and how could it not be true for drugs? The National Institute on Drug Abuse conducts yearly research (since 1975) on the prevalence of various drugs among eighth, tenth and twelfth graders. According to this survey, prescription drug use is the fourth most common reported used drug behind alcohol, tobacco and marijuana.<sup>xviii</sup> There are many different reasons as to why teens partake in drug use...being medicated is only one. I think perhaps our approach to adolescent drug use should be updated. Perhaps if we got real about the reasons behind the why teens take drugs we might be able to make a difference. For example, one reason an adolescent might take a friend's Adderall is because they want to perform better on a test. What is the reason behind that why? Students are in competition to get good grades which will in turn (hopefully) get them into a good school. What ever happened to just learning? When did every single student become "awesome"? The sad fact, is that if drug abuse is a real problem for American society...we should really look at the society. Ah, I digress.

### **The Lesson: Instructional Implementation**

Psychology teachers are lucky...for many reasons. We get to teach an academic elective and with AP, we get to teach kids who generally want to learn. Furthermore, Psychology is an interdisciplinary study so more than likely students will find something that resonates with them at some point in the year. Though these are advantages, I think there is a slight drawback- which is having to choose which unit of study to use to implement the information provided in the seminar. Truly, you could use any topic; I've decided to limit this curriculum unit to Research, Biology, Drugs and Consciousness, Stress and Health and Treatment. The nature of this curriculum unit is a year-long presentation of information that students will use after the AP exam in May. I will suggest specific links between the course and this curriculum unit to aide in the delivery of necessary information for students' final project.

### Teaching Strategies

#### *Words*

AP Psychology has no prerequisite and ANYONE brave enough to take the course may elect to do so. Therefore, it is imperative students gain a basic understanding of terms and concepts presented in the course. I give a year-long vocabulary assignment, full disclosure...I abhor grading this project, even so it is highly effective and it provides students with a technique they can use in other courses. I forgo the traditional warm-up and offer students time in class, usually between 20-30 minutes to work on this vocabulary assignment. This time also gives me a chance to take attendance, set up the lecture, aide students' understanding and get to know students better. It gives students time to switch gears and provides a routine they can expect every day. Students work on vocabulary from whatever unit we are currently covering- and they know whichever chapters are on the test provide the word banks for the note cards. To add to consistency and expectation the note cards are collected on each test day. I require students to



adhere to a format that makes the chore of grading easier to manage and we decide, as a class, on an ink color to dissuade students from using previous students' note cards. On the blank side students write the term in the top right corner and the unit in the bottom right corner- this allows for easy flipping to check that students met the term count. On the lined side students define the word verbatim or layman. They'll skip a line and provide an application based example; for biological terms they are allowed to draw the example. After flipping to check the count I pull five random cards to grade for accuracy. I deduct ten points for each underqualified example, incorrect format and definition. Even if students never complete a single assigned reading- they, at the very least, become familiar with the terminology and that connection from brain to hand helps as well.

### *Quizzes*

The pop quiz! Students dislike these, but they offer a quick assessment and rapid clarification for concepts discussed the previous day or from assigned reading. I use the call out method and students write their answers on their blank sheet of paper. The quiz is usually ten questions long and students grade their own quiz- with different ink. I may ask for a definition, example, term or compare and contrast question depending on the day. This provides me with evidence of student comprehension and whether or not they do the required reading at night. I typically do not ask questions that I did not go over in class...it's AP but they're still high school students. During the bio unit I may ask students to draw and label the neuron, describe action potential or ask about the job of particular neurotransmitters. These should just be basic questions that check for student comprehension of the mechanics of a particular concept.

### *Lecture Notes*

I post my power points online for students to print out and bring to class. My slides reflect college-style presentations with minimal words. Students are asked to listen, jot down additional information and questions they have during lecture. I do offer discussion boards that are directly linked to lecture notes. I also embed videos or provide additional links for students to explore on their own (or I show them in class if there is time).

### *Collaborative Slides*

Modern technology provides a fantastic avenue for students to collaborate from home. Often times I will forgo a lecture and ask students to prepare a Google Slide Presentation. I create the skeleton presentation based on the desired concepts I want the students to explore. I ask students to expand on the ideas I present by way of personal or researched examples, links for additional information and questions that arise from their personal discoveries. This provides a platform of student-directed learning...and often times I learn new methods of presenting the information. In my school we take full advantage of Google Apps and most teachers use Google Classroom as the class website. We are currently transitioning to a new platform, Canvas, but I feel most people who come across this CU will have knowledge of Google Classroom.

### *Think-Pair-Share*

This is a great method to use in larger classes where quieter students' can be overlooked. This is a well-known strategy and enhances any group discussion. Students think silently then share with a partner and finally I ask for volunteers to share with the rest of the class. Students are so afraid of being wrong that the second step of pairing increases their confidence and they become more willing to share with the class.

### *Grouping for Projects*

There are different philosophies about how we group our students...I think the success of one method (hetero vs homogenous grouping) over the other depends greatly on the type of activity students are participating in. For example, for school projects assigned for outside the school I use heterogeneous grouping, as students who choose their group usually pair up with classmates that share extracurricular activities. This grouping option aides in scheduling conflicts especially when adolescents are building their college resume with work, clubs, sports, etc.

### *Writing*

At our school, promoting writing and literacy skills is a goal that our administration likes to refer to as our north star. Writing for AP Psychology takes a bit of work because of students' traditional understanding of "essay". The requirement for students to write examples on their vocabulary serves as a basis for learning how to format their writings for the AP exam. I use previous writing prompts published on AP Central throughout the year to familiarize students with the free response questions on the exam. I sometimes adapt the prompt to whatever unit of study we are working on to increase the relevance. I also have students use rubrics to score their peers' essays. I feel this type of peer review actually makes them better writers.

## **In the Classroom**

### Lesson One: Teaching Research Methods

I know many AP Psychology teachers differ on their opinion about how they set of the order of topics they cover in the school year. I like to start with the history of psychology and how it involved into a science- quickly followed by research methods as it is the application of proof of scientific basis in Psychology. This unit is dry- for sure, but kids are comfortable with it because they are familiar with the information...they were taught the scientific method almost every year in science class since seventh grade.

This lesson should come after discussions about a scientific attitude and descriptive methods of research. The information I learned in this seminar can actually give students a real-life example of science- that they probably never considered. I will start by discussing trial and error and how this is an important method of scientific discovery and experimentation. Which would be a great place to input information about how chemists use an assay to begin the drug discovery process. I will then lecture on the experimental method of research- noting the importance of operational definitions and the use of placebos to ensure validity and causation in the research. I'll use the real-

life scenario of pre-clinical trials. I plan to get students to think about drugs and how and what would make them ready for clinical trials. Hopefully, students will navigate the conversation towards how the drug is measured for toxicity and efficacy. I believe this would take us to a lively debate about ethical guidelines for research. If there is time, I plan to continue the lecture into at least first phase of clinical trials- using this as a tool to teach about gathering and analyzing data.

### *In-Class Lessons*

I must be honest...I love teaching the Biological Basis for Behavior unit! Students may have previous knowledge of some of the concepts, which is cool and yet, I get to see them make connections between what goes on in their head and their corresponding behavior. At the beginning of each quarter, I provide my students with an agenda that provides them when and what we will talk about in class, nightly reading, tests and other extraneous information. This is highly effective and I recommend, especially for the Bio unit, that students read the material prior to the lesson. I provided an example in the appendix of how I format.

### Lesson Two: Introduction to the Nervous System

Day 1: I assign readings from the text book prior to our first lesson, no more than ten pages...this enables students to be active participants in the lecture. I start with the basics- neural anatomy and the underdog, glia. We discuss three basic types of neurons: two peripheral nervous system neurons, afferent and efferent, which send sensory and motor messages to and from the CNS; interneurons, located in the central nervous system, which receive information from the peripheral. After the lecture, I have students link hands and make a circle. I tell them that explaining what and how the brain processes information, like a pinch, takes a "million times" longer than the actual behavior. Then I start a chain reaction- I squeeze one student's hand and then I time how long it takes for the squeezing to get back to me. Because I am evil, I have the students remain linked and I start the process, only this time I don't stop the squeezing circle- rather, I tell them they can't stop the chain until I say. Then I describe the afferent route the sensation takes to the interneuron to the brain then how (and where) the brain processes the information and delivers the ordered response which travels back down the interneurons to the motor neurons which makes the hand squeeze sequence possible. After I explain this, I wait for the squeeze to come back to me and time it again- usually the time is significantly shorter. Then (without touching) we discuss why this happened... yay networks! If I'm feeling frisky, we do the same thing except we hold our neighbor's ankle and time the chained reaction; afterwards we discuss why this takes longer than the hand chain. Students love this activity. For homework, students should complete the required reading to prepare them for the next day's lesson.

Day 2: Students now have an understanding of the anatomy of the neuron. Usually I quiz them on this day to check for understanding and whether I should re-loop the information. I then lecture about neural communication and the roles of neurotransmitters. Student understanding of neural impulses can be a little hairy which is why I use pictures and videos to show what happens during an impulse (see teacher recourses). After we understand what is involved with message delivery we talk about chemical messengers. This is where I plan to talk about how drugs affect neural communication- via agonist and antagonists. Most students are familiar with the anti-depressant drug, Prozac so I will use this drug to demonstrate how drugs can affect neural communication. We will talk about Prozac at the synaptic level and the classification of the drug grouping of

serotonin reuptake inhibitors (SSRIs). Even if students aren't adept at understanding chemical compounds they can understand images of similar molecules...in theory this could offer them a visual of how drugs find chemicals to bind to. I provided these visuals in the handouts appendix for you- don't worry, they are only meant to provide a visual comparison of drugs and the corresponding chemicals they affect. At this point we are probably at about 45 minutes of lecture time- sans quiz time which means I might be losing my pupils. Because of our 90-minute block scheduling I suggest stopping here for the day and giving the students a fun activity to recap the information. Perhaps have students personify each of the neurotransmitters via character drawings that represent the function of each. Then perhaps demonstrate the serotonin-prozac relationship with a quick comic book style interaction.

Day 3: Whew...as a review for the previous day, I will give students additional time to complete their finishing touches on their neurotransmitter personification assignment (could be turned into a longer project- maybe creating a comic book devoted to neural communication). After review, I suggest using the information from the seminar to enhance the lecture...asking students to ponder how Prozac works within the brain but why antibiotics, like penicillin don't. We'll talk about the common delivery method (by mouth) and then I'll discuss the metabolism of each of the drugs. So...if they are both taken orally and both metabolized by the liver, how can penicillin not affect the central nervous system- enter the blood brain barrier (BBB). The focus will not be on the process of metabolism as it is severely complicated and frankly, I don't grasp it well enough to try and teach it. I will simply point out that both drugs are metabolized by liver enzymes and switch the focus back to the central nervous system by way of the BBB. We will explore how the barrier works and protects, when it is more susceptible and vulnerable to foreign invaders. I will ask students to quickly research CNS and when they were developed and available for mass production...why aren't there more? Is mental health really not worth it? Which will lead us into discussing the difficulties involved with CNS drug development.

### Lesson Three: Teaching about Stress and Health

The final project requires students to create a campaign dissuading teenage drug use. In this unit, students will learn about how stress affects the physiological state and how individuals develop coping habits. Students will research how habits are formed, specifically those that are based in avoidance or escaping stressors. These methods (gaming, binge watching Netflix, substance abuse) tend to be the most convenient for adolescents. I will then ask students to choose a partner and research methods of managing and coping with stress. They will collaborate on a Google slide presentation which can be used as a resource for their final project.

### Lesson Four: Treatment of Mental Disorders

After lecturing on traditional methods of talk therapy we will discuss the option of biomedical therapies as treatment for psychological disorders. At this point in the year, students should have a good understanding of how neurons and neurotransmitters act within the brain. As a class we will look at anxiety and attention disorders and how they are treated with medication. I will incorporate information about the blood brain barrier and how CNS drugs are used to treat specific maladies and the adverse effects of taking CNS drugs with no biological need. Students

will then create a treatment plan for a mock patient who is diagnosed with a mental disorder. The plan will include the:

- Diagnosis
- Symptoms of the disorder
- Biological origins of the disorder
- Medication used for treatment and how it affects neural activity
- The Relevance of time and talk therapy on the patient.

This treatment plan will serve as a practice activity for their unit exam on this material.

### Lesson Five: Social Influence

This will be a brief lesson about the group influence on individual behavior- specifically connecting it to the competitive nature at Hough. I will be sure to include information about the types of conformity and explain how normative and informative social influence look within a group setting. For example, normative social influence may drive students to sign up for multiple AP courses if the rest of their friend group are college-bound. They sign up because they do not want to be ostracized by the group by not taking a challenging course. On the other hand, these same students who sign up for AP classes because of their friends may also be affected by the informative social influence. These students are more likely to take study drugs if they are told by someone that the drugs help with the work load and have no side effects (especially if they have no previous knowledge about the drug). Hopefully, this lesson will increase the amount of information students have at their disposal for their final project.

### Assessments

I think tests are a necessary evil. I think traditional tests are a quick way to gage students' understanding and it's not the only nor the most effective method. I am partial to quick ten question pop quizzes, essays and projects. Teachers I think both loathe and appreciate group projects- they allow for reduced grading and alternative outlets for students to portray their gained knowledge.

### Student Project- The Culmination of Material

I think this project would be best if assigned for the end of the year in the interim between the AP exam in May and the end of the school year. I see this as a collaboration piece for three individuals. The project will be a public service announcement for the benefit of the school. The campaign will have three parts: background research; brochures and posters; a short informative commercial. Students will present their campaign the last week of school. Below are the necessary requirements and rationale for each part. The rubric can be found in the teaching materials appendix.

## Appendix I- Teaching Standards

North Carolina Department of Instruction creates a standard course of study for courses offered in North Carolina. They adapted the College Board's standards to fulfill formatting requirements, thus this curriculum unit follows the standards provided by the state.

This curriculum unit's time frame is flexible, so whomever teaches it may choose to address particular standards at various times throughout the year. In my own course I tend to follow the course outline as AP Central suggests- with few variations. Early in the year we cover research methods in the beginning- the first standard is to distinguish between different research strategies. This would be a great time to incorporate information on how a drug must meet ethical guidelines set forth by the Food and Drug Administration (ie the various phases of clinical trials to prove safety and efficacy).

After research we delve into biology- this is obviously important for students to grasp how neurons function within communication and how drug interferences affect such communication. This would satisfy many standards offered in the course of study- specifically the following: identify the structure and function of a neuron; describe and explain the organization of the nervous system; categorize the different psychoactive drugs and their effects. This also ties into later units of study that address biological approaches to therapies. Typically, I save this unit for the end of the course.

In order for the student project to be successful, it would be beneficial for students to understand the psychological and physiological reactions to stress and the methods to which many adolescents develop coping habits. This will better inform their PSA project that they will work on after the exam.

Lastly, I think it is important to note the relevance of social aspects on adolescents- specifically those who attend an academically competitive school like Hough. As I stated earlier in this unit, study drugs are increasingly available to students; group dynamics may influence the likelihood of a student taking these academia drugs. If students can understand how the structure and function of a group influence them, then they may be cognizant of their personal choices to partake in such activities to propel them academically.

North Carolina Department of Instruction creates a standard course of study for courses offered in North Carolina. They adapted the College Board's standards to fulfill formatting requirements, thus this curriculum unit follows the standards provided by the state. I listed the exact standards below:

- Distinguish between different research strategies used by psychologists to explore behavior and mental processes.
- Identify the structure and function of a neuron.
- Describe and explain the organization of the nervous system.
- Categorize the different psychoactive drugs and their effects.
- Explore psychological and physiological reactions to stress.
- Compare and contrast treatment approaches such as biological approaches.

- Illustrate how the structure and function of a given group affects the behavior of the group and the individual.

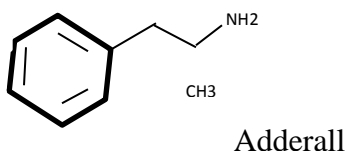
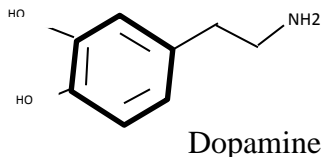
## Appendix II

### Example of Student Agenda

<b>Dates</b>	<b>In-Class Topic</b>	<b>HW</b>	<b>Extra</b>
Sept	Header Topics...determines which notes to bring to class	Pages to read prior to date provided	Info about class, in class activities, quizzes projects, etc
18 19	Test 1	Read pgs 51-61	
20 25	Bio Neuron/ Nervous System	Read pgs 62-68	9-21/22- Work Days Types of Neuron Circle
26 27	Bio NS and Endocrine System	Read pgs 68-82	Personification of neurotransmitters
28 29	Bio Brain and Tools to study	Read pgs 82-92	
10-2 10-3	Bio More Brain	Read pgs 92-113	
4 5	Bio Genetics	Essay Study for Test	
6 9	Test 2; Unit 3 Bio	Read pgs 115-128	Ntcds Due
10 11	Sensation Basics and Vision	Read pgs 128-140	
12 13	Sen Vision/Hearing	Read pgs 141-165	Outdoor Sensation
16 17	Sen Other Senses and Perception	Read pgs 166-174	
18 19	Perception and Consciousness	Read pgs 176-192	18-Early Release Day
20 23	Con Sleep Dreams	Read pgs 192-198	
24 25	Con Hypnosis and Drug	Study	
26 27	Drug Effects	Read pgs 255-277	Q1 Ends 10-31 Workday

### Appendix III

#### Chemical Structures of Dopamine and Adderall



### Appendix IV

#### PSA directions and rubric

Directions: Students will work in pairs or groups of three to design a PSA campaign about adolescents' experience with stress in high school. The group will work to write a research paper on adolescent stressors and response to stress. Additionally, students will create an extension of their research via PSA.

#### Background Research

- Common stressors of adolescents and physiological response to stress
- Influence of social groups on creation and response to stress
- Mental Health in adolescents (importance of, prevalence of diagnoses and medication)
- The use of prescription drugs (study, anxiety, pain) and other illicit drugs among teens
- Negative coping habits (avoidance/escaping) adolescents commonly use and how they are developed
- Positive strategies to manage and cope with stress

#### Paper

- 5-8 pages, typed, times new roman-12 font, Chicago format, include title page
- Topics covered:
  - Stressors
  - Social influence
  - Mental health
  - Negative coping habits
  - Positive coping habits

PSA- Should be an extension of the research...not regurgitation

Print: Flyer and pamphlet

- Should be an efficiently informative product that increases awareness about:
  - Common stressors
  - Damage of negative coping mechanisms
  - Importance of positive coping strategies
- Design elements are geared towards target population (adolescents)

Video: 30 seconds- minute

- Message should be about the importance of mental health and well-being
- Dangers of succumbing to peer pressure
- Students will vote as a class on the most effective PSA campaign. The group's product will be posted around campus and in the student services office. The video will be aired on the school's closed circuit TV channel during morning announcements.



Rubric:

Example of PSA rubric

	5	4	3	2	1
<b>Paper: Mechanics</b>	Paper expertly meets specifications. 5-8 pages, citations, Chicago format. Demonstrates exceptional grasp of the English language, the paper is eloquently written. No grammatical errors.	Paper successfully meets specifications. 5-7 pages, citation, Chicago format. Demonstrates an understanding of the English language effective writing. There may be some grammatical errors	Paper meets specifications: 5-6 pages, citations, Chicago format. Demonstrates an effective linguistic ability- there may be unclearly or underdeveloped ideas. Some grammatical errors.	Paper meets some specifications: length, citations and Chicago formatting. The writing exhibits a poor grasp of language- there are many grammatical errors.	Paper lacks proper formatting or length. The writing is limited in skill and is ineffective and underdeveloped. Grammatical errors are distracting.
<b>Paper: Content</b>	The paper is a thoughtful portrayal of student application of research. Expertly addresses all five criteria. Demonstrates an elaboration and expansion of ideas that clearly shows a superb synthesis of information.	The paper demonstrates a good use of research that successfully addresses all five criteria. The use of additional information is present and shows evidence of student comprehension.	The paper is a product of solid research. All five criteria are presented in the paper. There is some additional information that demonstrates student comprehension.	The paper has evidence of research. There may be missing criteria. Students show some understanding of the material.	The paper shows little to no foresight and execution of research. There are criteria missing. Students show little understanding of the material.

Product	5	4	3	2	1
<b>Print: Design</b>	Print material demonstrates expert skill at creating a truly effective presentation of ideas. The product design is perfectly in tune with target audience. Excellent command of visual and spatial design elements. Shows incredible foresight and planning.	Print material shows an efficiently effective presentation of ideas. The design elements are successfully geared towards the targeted audience. A solid grasp of visual portrayal of information. Evidence of planning.	Print material presents ideas successfully. The design work is aimed at targeted audience and may exhibit some understanding of visual effects and design. There is evidence of planning.	Print material may lack a clear message for targeted audience. There is some thought and planning evident in the visual design.	Print material is ineffective at delivering information. There is no target evidence. Design looks last-minute with little to no thought for visual design.
<b>Print: Content</b>					
<b>Video: Production</b>	There is evidence of foresight and fine attention to detail which allowed students to execute production easily with professionalism and finesse.	There is evidence of planning and understanding of information. This is a good quality video production with purpose.	The video has good information. There is some evidence of planning and understanding of material. Video is produced with purpose.	The video may have good information but may lack planning or understanding of material. The video may lack quality of production.	Video may lack correct information and planning. There is little thought to production.
<b>Video: Content</b>	The video is a true extension of material and is an effective delivery of information targeted to adolescents. Video demonstrate an ownership of the information. The product represents incredible comprehension of the assignment.	The video is a reflection of student research and is more than a regurgitation of information. Video is an effective transference of information. The video is effective in reaching the goals of the assignment.	The video demonstrates an understanding of information that delivers content to the targeted audience. The video may only restate information learned during research.	The video may lack information or may give misinformation. There is some evidence of research with little ownership of information.	The video failed to deliver information and may lack an understanding of the assignment.

## Resources

### Resources for Students

Abuse, National Institute on Drug. "Monitoring the Future Survey: High School and Youth Trends." NIDA, [www.drugabuse.gov/publications/drugfacts/monitoring-future-survey-high-school-youth-trends](http://www.drugabuse.gov/publications/drugfacts/monitoring-future-survey-high-school-youth-trends).

This site offers statistics on drug use among adolescents and is a great place for students to begin their research for this curriculum unit student project.

Anderson, Norman B, et al. "Stress in America." American Psychological Association, 11 Feb. 2014.

This is another project resource that can offer background information for students when developing the PSA. The site explains which stressors are most prominent among adolescents.

"Introduction and Neurotransmitters (Memorable Psychopharmacology 1 & 2)." YouTube, YouTube, 16 May 2014, [www.youtube.com/watch?v=uhmpi3yLeGg](http://www.youtube.com/watch?v=uhmpi3yLeGg).

This is a wonderful "dumbed-down" explanation of neurotransmitters for students and even better...it's a video. It also provides some helpful mnemonics.

"Mental Disorders." Teen Mental Health. Accessed October 27, 2017.

<http://teenmentalhealth.org/learn/mental-disorders/>.

This is a wonderfully produced webpage for information about mental health in adolescents. Topics not only include the basics of mental health but also promoting health, coping with mental disorders and community outreach.

Mouse Party. <http://learn.genetics.utah.edu/content/addiction/mouse/>.

A fun interactive tool that allows students to see how particular drugs affect the brain on the synaptic level.

"Neuroscience For Kids." Neuroscience For Kids - Smart Drugs, [faculty.washington.edu/chudler/smartd.html](http://faculty.washington.edu/chudler/smartd.html).

A great start for research into common drugs for adolescents- especially in the growing popularity of the smart drug epidemic

"Pharmacology - ANTIDEPRESSANTS - SSRIs, SNRIs, TCAs, MAOIs, Lithium (MADE EASY)." YouTube, YouTube, 10 Nov. 2016, [www.youtube.com/watch?v=T25jvLC6X0w](http://www.youtube.com/watch?v=T25jvLC6X0w).

This video is about neural communication and drug actions on the synapses/receptors. This would be a great video to assign as homework, in conjunction with reading, during the unit on biomedical therapies. It offers visual representation of drug interactions- great for students and teachers.

"Prescription Drugs." NIDA for Teens. March 01, 2017. Accessed October 27, 2017.

<https://teens.drugabuse.gov/drug-facts/prescription-drugs>.

This is a comprehensive website that specifically educates the viewer on common misused and abused prescription drugs. More importantly, the site addresses the dangers of misuse and the effects of the drugs on the developing brain.

### **Resources for Teachers**

“Challenging Medicines: Making Medicines - Practicals and PPT- Learn Chemistry.” Royal Society of Chemistry - Advancing excellence in the chemical sciences, [www.rsc.org/learn-chemistry/resource/res00000924/challenging-medicines-making-medicines-practicals-and-ppt](http://www.rsc.org/learn-chemistry/resource/res00000924/challenging-medicines-making-medicines-practicals-and-ppt).

This is a great link that offers a power point on the drug discovery process and has additional links for further investigation and clarification. Would be a great back up source for teachers and a great visual for students.

“Neuroscience For Kids.” Neuroscience For Kids - blood brain barrier, [faculty.washington.edu/chudler/bbb.html](http://faculty.washington.edu/chudler/bbb.html).

If you never really had to consider how some drugs affect the brain and don't affect the body- then this is a great place to start. This site clarifies (in the most basic ways) how the blood brain barrier works.

Rader's Chem4Kids.com. Rader's Chem4Kids.com.  
[http://www.chem4kids.com/files/react\\_intro.html](http://www.chem4kids.com/files/react_intro.html).

If you are completely inept as I am in chemistry, this is a wonderful website that dusts off the information you learned in high school that you tucked away in your brain as “things I'll never use again”. It provides even the most basic concepts; such as how chemical reactions happen.

## Bibliography

“Advanced Placement Psychology.” North Carolina Department of Public Instruction, 6 June 2005.

This is the North Carolina Department of Public Instruction’s adaptation of college board’s standard course of study for APPSYCH.

"ADHD Sufferers-Pay Attention: Heres How Vyvanse Works." ADHD Sufferers-Pay Attention: Heres How Vyvanse Works | American Council on Science and Health. Accessed November 15, 2017. <https://www.acsh.org/news/2016/09/23/adhd-sufferers%E2%80%94pay-attention-heres-how-vyvanse-works-10206>.

This site informs the reader about different ADHD medication and also shows chemical structures for the drugs aimed to combat ADHD.

Alavijeh, Mohammad S., Mansoor Chishty, M. Zeeshan Qaiser, and Alan M. Palmer. "Drug Metabolism and Pharmacokinetics, the Blood-Brain Barrier, and Central Nervous System Drug Discovery." *NeuroRx*. October 2005. Accessed October 27, 2017.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1201315/>.

This article explains the complicated world of pharmacokinetics with specific insight into how the blood brain barrier works to deter both drug discovery and drug efficacy.

“Brain confusion: Why it's so difficult to find cures for mental disorders.” Genetic Literacy Project, 9 July 2015, [geneticliteracyproject.org/2015/07/09/brain-confusion-why-its-so-difficult-to-find-cures-for-mental-disorders/](http://geneticliteracyproject.org/2015/07/09/brain-confusion-why-its-so-difficult-to-find-cures-for-mental-disorders/).

This journal article explains why it is difficult to find cures for mental disorders. There is some discussion of genetic pathways and how the new information about the origin of mental disorders can give insight into more efficient means of drug discovery for CNS.

Dereksimonphd. "Posts about neurotransmitters on Dr. Simon Says Science." *Dr Simon Says Science*. Accessed November 15, 2017.

<https://www.drsimonsayscience.org/tag/neurotransmitters/>

This website provides information about the chemical structures of neurotransmitters.

Herper, Matthew. "The Coming Boom In Brain Medicines." *Forbes*. February 12, 2015. Accessed November 15, 2017. <https://www.forbes.com/sites/matthewherper/2015/02/11/brain-boom-the-drug-companies-bringing-neuroscience-back-from-the-brink/#c9f46631cb73>

This is a great current article that delves into the new gene pathway science that will make CNS drug discovery more accessible to pharmaceutical companies.

Insel, Thomas. “Post by Former NIMH Director Thomas Insel: Treatment Development: The Past 50 Years.” National Institute of Mental Health, U.S. Department of Health and Human Services, 14 Dec. 2011, [www.nimh.nih.gov/about/directors/thomas-insel/blog/2011/treatment-development-the-past-50-years.shtml](http://www.nimh.nih.gov/about/directors/thomas-insel/blog/2011/treatment-development-the-past-50-years.shtml).

This blog talks about the history of treating mental disorders in the past 50 years and the continued outdated methods used to identify alternative treatments for mental health.

Insel, T.R., et al. "Innovative solutions to novel drug development in mental health." Neuroscience and Biobehavioral Reviews, Pergamon Press, Dec. 2013, [www.ncbi.nlm.nih.gov/pmc/articles/PMC3788850/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3788850/).

This is an article that states complications of nervous system drug treatments and also explains the new science that is allowing CNS drugs the possibility of becoming regularly researched and developed drugs.

Lebowitz, Barry D., and Herbert W. Harris. "Drug discovery and mental illness." Dialogues in Clinical Neuroscience, Les Laboratoires Servier, Dec. 2002, [www.ncbi.nlm.nih.gov/pmc/articles/PMC3181695/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3181695/).

This article explains the relationship between drug discovery and mental illness. The article provides insight into the evolution of drugs aimed at mental illness. This is in easy-to-understand text that provides much detail.

Rick Mullin, Chemical & Engineering News. "Cost to Develop New Pharmaceutical Drug Now Exceeds \$2.5B." Scientific American. November 24, 2014. Accessed November 15, 2017. <https://www.scientificamerican.com/article/cost-to-develop-new-pharmaceutical-drug-now-exceeds-2-5b/>.

This article describes the why and how of pharmaceutical drug development costs.

"What is Psychopharmacology." ASCP American Society of Clinical Psychopharmacology. <http://www.ascpp.org/resources/information-for-patients/what-is-psychopharmacology>.

This website is dedicated to all things psychopharmacology. It is a great place to find current research about drugs.

- 
- <sup>i</sup> "TheGrade." College Acceptance Rates in North Carolina, 2017. [www.thegrade.co/acceptance-rates/north-carolina/](http://www.thegrade.co/acceptance-rates/north-carolina/).
- <sup>ii</sup> Rankings, National. "How Does William Amos Hough High Rank Among America's Best High Schools?" U.S. News & World Report, U.S. News & World Report.
- <sup>iii</sup> Lebowitz, Barry D., and Herbert W. Harris. "Drug discovery and mental illness." *Dialogues in Clinical Neuroscience*, Les Laboratoires Servier, Dec. 2002.
- <sup>iv</sup> Rankings, National. "How Does William Amos Hough High Rank Among America's Best High Schools?" U.S. News & World Report, U.S. News & World Report.
- <sup>v</sup> "What is Psychopharmacology." *ASCP American Society of Clinical Psychopharmacology*.
- <sup>vi</sup> Rick Mullin, *Chemical & Engineering News*. "Cost to Develop New Pharmaceutical Drug Now Exceeds \$2.5B." *Scientific American*. November 24, 2014. Accessed November 15, 2017.
- <sup>vii</sup> "Assessing a Decade of Viagra." *NPR*, NPR, 27 Mar. 2008
- <sup>viii</sup> "Neuroscience For Kids." *Neuroscience For Kids - blood brain barrier*
- <sup>ix</sup> "Brain confusion: Why it's so difficult to find cures for mental disorders." *Genetic Literacy Project*, 9 July 2015
- <sup>x</sup> "Cerebrum." *Psychiatric Drug Development: Diagnosing a Crisis*, 2 Apr. 2013.
- <sup>xi</sup> Insel, Thomas. "Post by Former NIMH Director Thomas Insel: Treatment Development: The Past 50 Years." *National Institute of Mental Health, U.S. Department of Health and Human Services*, 14 Dec. 2011
- <sup>xii</sup> Alavijeh, Mohammad S., Mansoor Chishty, M. Zeeshan Qaiser, and Alan M. Palmer. "Drug Metabolism and Pharmacokinetics, the Blood-Brain Barrier, and Central Nervous System Drug Discovery."
- <sup>xiii</sup> Herper, Matthew. "The Coming Boom In Brain Medicines." *Forbes*, *Forbes Magazine*, 12 Feb. 2015
- <sup>xiv</sup> "Cerebrum." *Psychiatric Drug Development: Diagnosing a Crisis*, 2 Apr. 2013.
- <sup>xv</sup> Health, Office Of Adolescent. "Adolescent Mental Health Basics." *HHS.gov*. April 28, 2017. Accessed October 27, 2017.
- <sup>xvi</sup> See note xv
- <sup>xvii</sup> See note xv
- <sup>xviii</sup> "Prescription Drugs." *NIDA for Teens*. March 01, 2017. Accessed October 27, 2017.