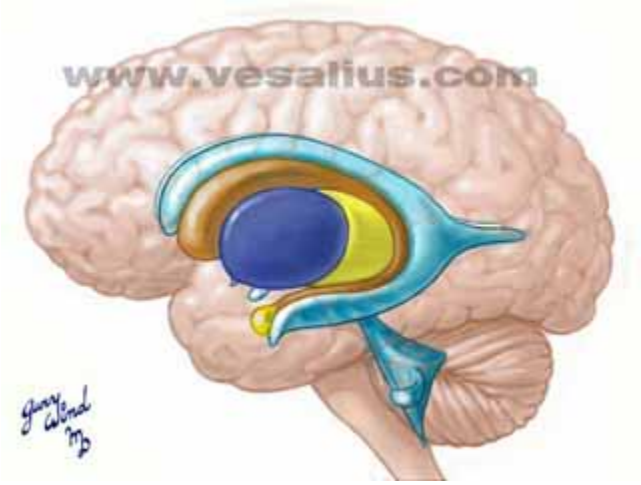
1. Education: The Biology of Depression

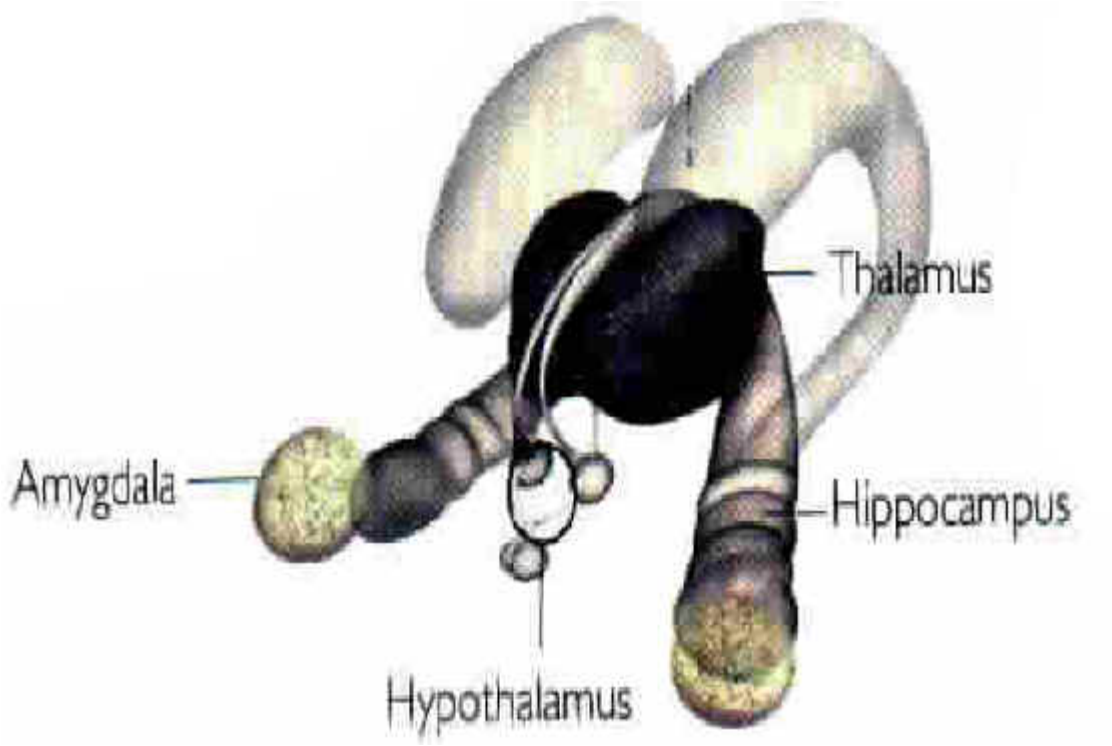
The Brain

In understanding how antidepressant medications work it is helpful to have a little knowledge about the structure and function of the brain.

There are really three levels to your brain. The first is the core of the brain which includes the basal ganglia, the ventricles or circulation system to the brain, and the thalamus. The thalamus is considered the "relay station" for information that comes into the brain. This is the most primitive part of our brain. It is responsible for our basic drives and instincts. It focuses on meeting our most basic needs such as eating, staying safe, and responding to fear.

Yellow is the **thalamus**
Gold is the caudate nucleus
Purple is the putamen (the caudate nucleus, the putamen and the globus pallidus make up the **basal ganglia**, not shown globus pallidus)
Blue is the **circulatory system**



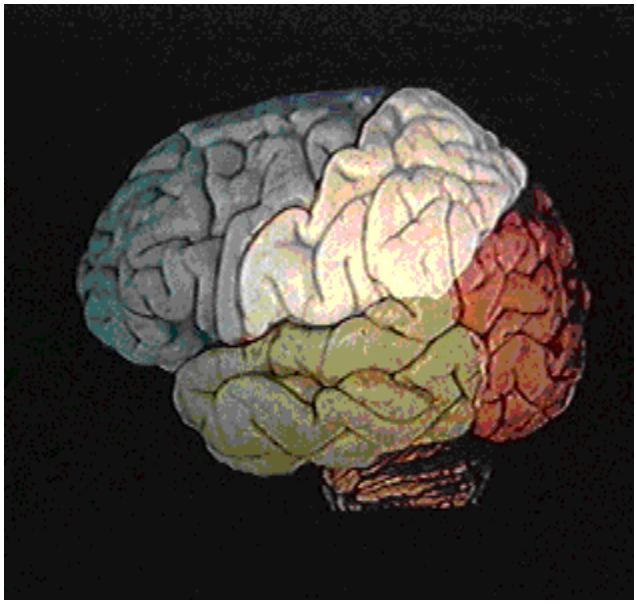


The second part of our brain is called the **limbic system**. The main parts of the limbic system include the **hypothalamus**, the **amygdale**, and the **hippocampus**. The limbic system is responsible for mood, memory and hormone control.

The **hypothalamus** regulates body temperature, controls thirst, appetite, circadian cycles, influences blood pressure, sexual behavior, aggression, fear, and sleep.

The **amygdale** is also involved in the regulation of our emotions.

The **hippocampus** is involved in memory, learning and emotion.



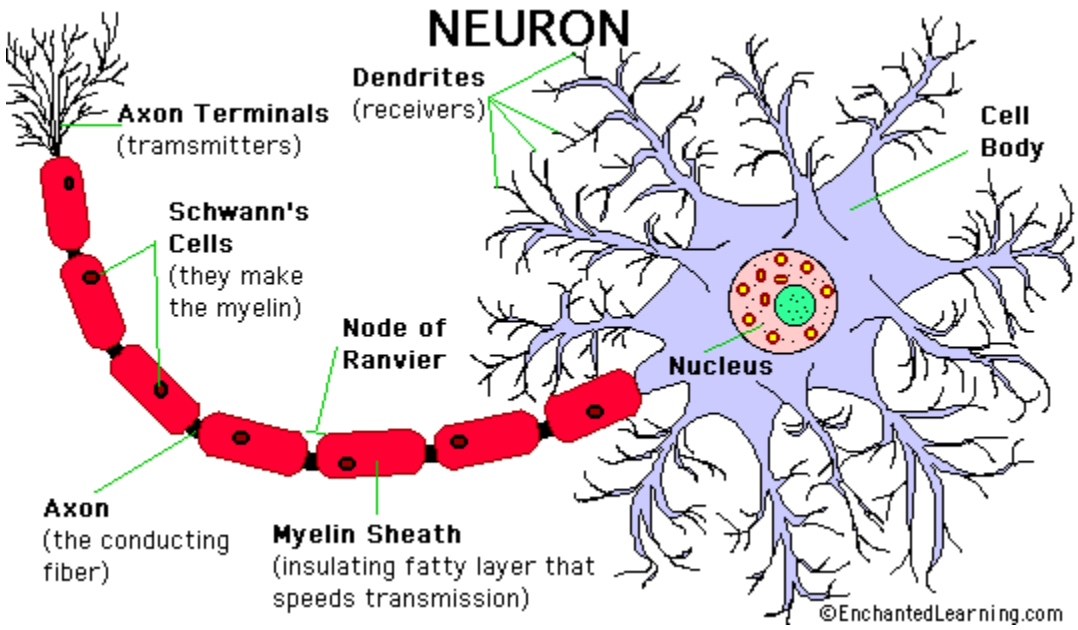
The third part of our brain, known as the **cortex**, is the most advanced and most recently developed. It allows us to think abstractly and to have complex social interactions, and communicate with the use of language. The back part of the cortex (orange) or the **occipital lobe** is related to vision. The top of the cortex (white) or the **parietal lobe** is related to sensation and muscle control. The front of the cortex (blue) or the **frontal lobe** is related to the ability to have abstract thoughts. Finally, the lower part of the cortex (green) is the **temporal lobe** which is related to memory, and speech.

As you can see by the multiple functions and body systems the brain affects **symptoms of depression show up in multiple systems** that are regulated by the brain. These include appetite, concentration, memory, pain, energy and motivation.

Communication in the Brain

In order for the brain to perform all its functions it needs to be able to communicate effectively. The brain does this in multiple ways. One of these ways is through **neurotransmitters** which are basically chemical messengers. You may have heard of some of them, **serotonin**, **norepinephrine** and **dopamine**. This communication occurs at a microscopic level between neurons in the brain.

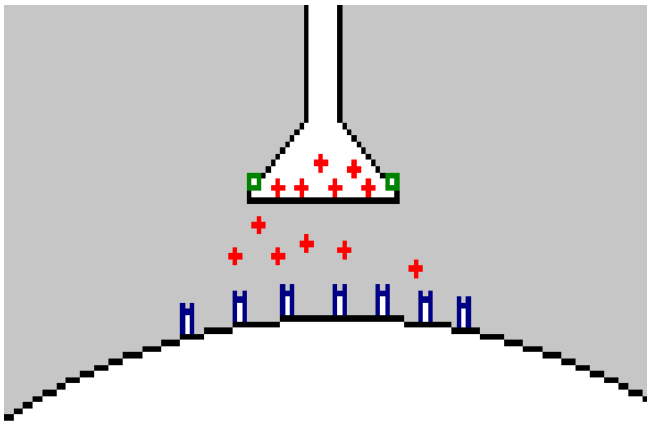
This is a picture of what a **neuron in the brain** looks like. Communication occurs between these neuron through the neurotransmitters released from the cell body.



Communication within the Brain

This is a picture of the **synapse** between two neurons. As you can see **Cell A** has released neurotransmitters to communicate to **Cell B** (red). **Cell B** has **receptors** that are **specific to these neurotransmitters**. (Blue) These receptors will only respond to the specific neurotransmitter that fits its receptor.
On Cell A you can see **green areas** which represent how the left over neurotransmitter in the synapse is taken back up into Cell A to be recycled and used again.

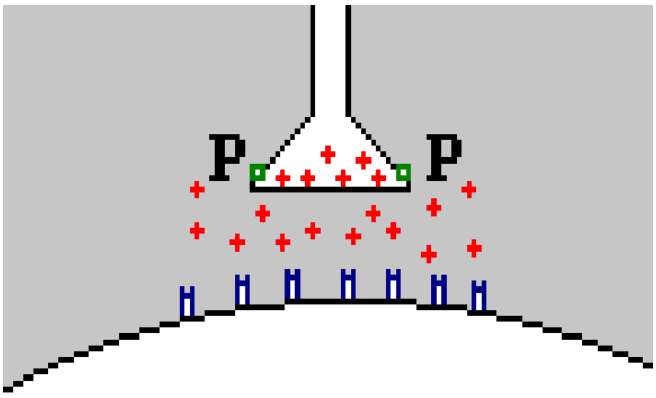
Cell A



Cell B

How Antidepressants Affect this Communication Process

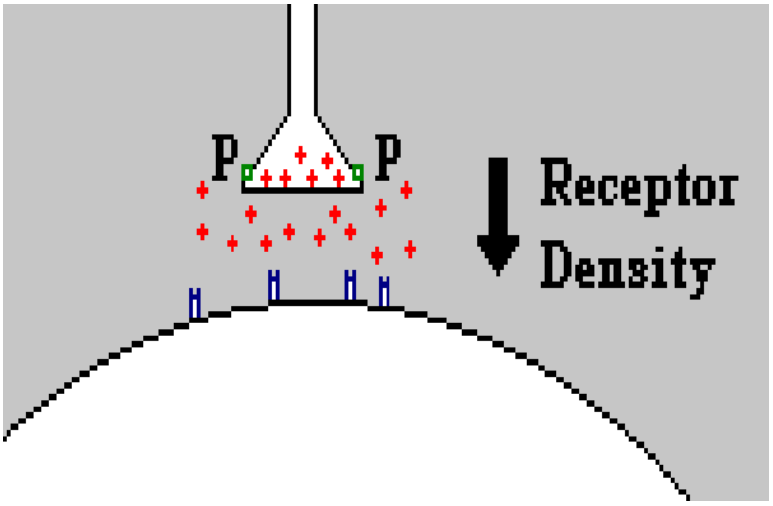
We know that antidepressants increase the amount of neurotransmitter available in the synapse, but how does it do this? There are two ways that antidepressants do this. The first is by **decreasing the amount of neurotransmitter being broken down by enzymes** in the synapse that "eat up" the extra neurotransmitters. The second way neurotransmitters are decreased is **by decreasing the amount of neurotransmitter taken back up into Cell A.** These medications are known as the Selective Serotonin Reuptake Inhibitors (SSRI's).



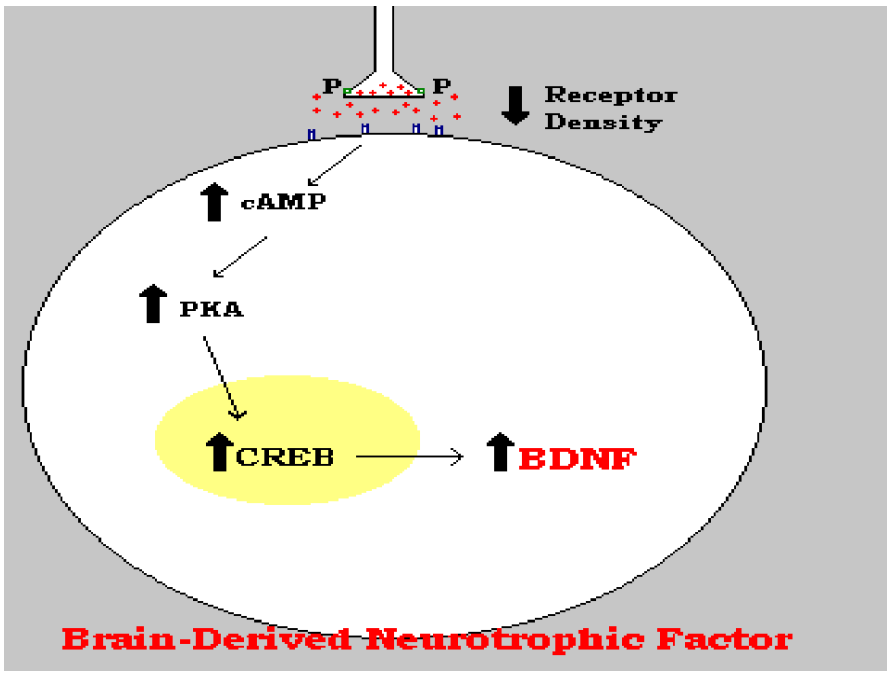
In this picture the "P" stands for **Prozac**. In a patient who was taking Prozac you would see that the **reuptake channels for the serotonin neurotransmitter were blocked**, ultimately leaving more serotonin available in the synapse. (Red) This is true of the other SSRI's like **Zoloft, Paxil, Celexa and Lexapro.**

Since the increase in serotonin occurs immediately after starting the medication then **why does it take up to 6 weeks to get the full affect** from the medication? Interestingly researchers are learning that it is what happens inside Cell B, the neurotransmitter receiving the message that really makes a difference.

Since there is more neurotransmitter available, it is easier for Cell B to receive the message from Cell A. Previously Cell B had **increased the number of receptors available to "hear" the message from Cell A.** (Similar to turning up the volume on a phone when the signal is weak.) Now that the signal is coming through easily it begins to **decrease the number of receptors available.**



As the number of receptors decrease another chemical inside the cell increases. This is called **"cyclic AMP" (cAMP)**. This is known as a **"second messenger"**. This sets off a series of reactions that result in an increase in a molecule known as **Brain-derived Neurotropic Factor (BDNF)**.



What is BDNF?

The latest thought is that this is the **final common pathway** through which all antidepressant treatments work, including **ECT,** other types of **antidepressants** and **even exercise**. Brain-Deprived Neurotropic Factor is a long name for a molecule within cells that **nurtures and promotes cell growth**. If BDNF is not available within a cell it decreases its activity and connections with other cells. This may explain why people who are depressed often feel slowed down, and have difficulty keeping up with everyday activities.

As you may remember we previously discussed how important **exercise** and **diet** were to managing depression. There is research in rats that show exercise increases BDNF within cells. These studies also showed **lower BDNF levels** in those rats that were given **a high-fat or high sugar diet**.

To further support this argument, studies in rats have been able to measure that during stress, **BDNF levels decline** and that rats that have been given Prozac do not have that drop in BDNF under stress. This implies that **being on an antidepressant may have protective factors against stress**. Stress has been considered a key factor in recurrent depression so it would make sense for patients with recurrent depressive episodes to stay on an antidepressant prophylactic ally.

Resource

**The previous section was adapted from Dr. Jim Phelps' Website:
www.psychoeducation.org

http://www.allaboutdepression.com/cau_02.html This website covers the biology of depression as well as other topics on depression.

www.opb.org/emedia (Tutorials on the Brain)

Disclaimer:

This written information is not intended as a substitute for medical or mental health care advice. Please be sure to discuss any questions or concerns you may have with a professional person.