

# THIS IS YOUR BRAIN ON DEPRESSION

## LESSON PLAN

**Title:** This is Your Brain on Depression

**Setting:** In Classroom

**Subject:** Biology - Neuroscience

**Grade Level:** 9-12

**Time Frame:** 1 Hour

**Paired Dana Foundation Fact Sheets:**  
9th-12th Grade How Does the Brain Work?

**Next Generation Science Standards:**  
Meets HS-LS1-2, HS-LS1-3

## STUDENT OBJECTIVES

- Learn about the etiology of depression and discuss behavioral symptoms.
- Learn and discuss the advantages and disadvantages of current treatment options, such as antidepressants.
- Work in groups to investigate what is going on in the brain during depression and how antidepressants target specific neural mechanisms to alleviate its symptoms.

## BACKGROUND

This interactive lesson plan teaches students about the causes, symptoms, and treatment options for teen depression.

## MATERIALS

- Printed copies of 9th-12th grade Dana Foundation fact sheet, “How Does the Brain Work?” Downloadable here: [www.dana.org/factsheets](http://www.dana.org/factsheets).
- Pencils and paper (enough for entire class).
- A whiteboard (or chalkboard).
- Two pieces of poster board, found on Amazon.com by searching Pacon Super Value Poster Board.
- Markers found on Target.com at <https://www.target.com/p/crayola-174-supertips-markers-washable-20ct/-/A-49085479>.

Please print the articles listed at the end of the lesson plan, under the “Research Articles” section. These articles will be provided to students for research purposes. The number of copies of each article will reflect the needs of the class. We recommend printing a copy of the article listed under “Introduction to Depression” for each student. The number of copies needed for the articles listed under “Articles for Group 1” and “Articles for Group 2” should be based on the number of students in each group. See the “Procedure” section for further instruction.

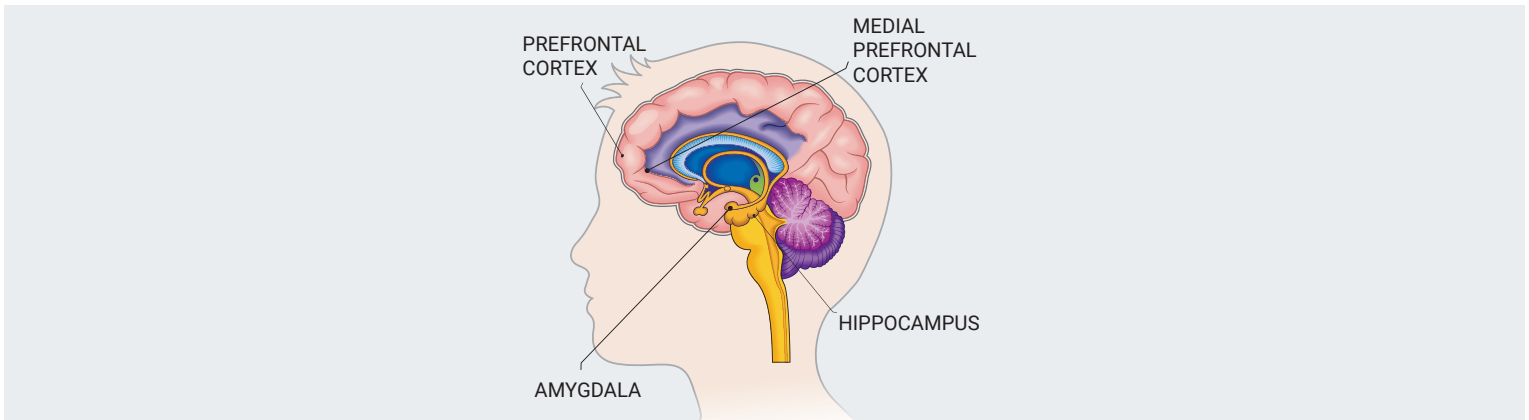
# THIS IS YOUR BRAIN ON DEPRESSION

## TEACHER BACKGROUND INFO

### WHAT TO KNOW BEFORE YOU TEACH

\* Note: This content is primarily for the instructor's reference.

## Depression



**Depression:** A mood disorder characterized by a persistent feeling of sadness and loss of interest that interferes with day-to-day activities.

### Causes: Biological

- Physical changes to the brain
  - Reduction in volume and activity in certain brain regions.
  - **Example: Reduced volume and activity in the hippocampus, prefrontal cortex, and amygdala.** These are all brain regions involved in how we process and handle emotions.
  - **Example: Reduced activity of the reward system in the brain, leading to lack of pleasure from something the depressed individual previously enjoyed.** The neuronal projections from the ventral tegmental area to the nucleus accumbens make up the reward system in the brain. This system is thought to elicit the rewarding, pleasurable effects we get from doing activities we enjoy.
- Changes in neurotransmitter signaling
  - Disruption of serotonin, dopamine, and/or norepinephrine signaling in the brain.
  - Functions of these neurotransmitters:
    - Serotonin: mood, emotion, sleep, appetite
    - Dopamine: movement, attention, pleasure
    - Norepinephrine: arousal, sleep, attention, mood

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### Depression

- Brain inflammation
  - New research suggests a link between neural inflammation and depression. The brain responds to insults by sending out inflammatory agents. Negative changes, such as neural degeneration, occur in the brain when these inflammatory signals become chronic and hyperactive.

### Causes: Experience

- Challenging, stressful or traumatic life experiences can cause depression for some individuals. Large individual differences occur in regard to the degree in which certain life experiences can make an individual more susceptible to depression.
- **Examples:**
  - **Childhood trauma**
  - **Death of a loved one**
  - **Job loss**
  - **High-stress situations**
  - **Financial stress**

### Causes: Genetics

- There is no confirmed link between genes and depression, but depression does seem to run in families (thought to be hereditary).
- Genetics may make an individual more susceptible to depression after a challenging life experience like one of the ones mentioned above.
- Pinpointing genes involved in depression is difficult because depression occurs in many different forms and has many different symptoms.
- It is likely that multiple genetic factors combined with life experiences and neural changes ultimately lead to depression.

### Causes: Cognitive

- Depression is often a “hidden” disorder. People may look and act healthy – especially young overachievers or teens great at sports, etc. However, cognitive disruptions such as “thought” disturbances, perfectionism, and negative attributional style can be underneath the surface.

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### Depression

#### Symptoms: Cognitive & Behavioral

- Depressed mood
- Difficulty concentrating
- Difficulty making decisions
- Increased anxiety
- Irritability
- Drop in grades
- Loss of interest
- Loss of pleasure
- Social withdrawal
- Lack of motivation
- A change from previous functioning (experiencing symptoms not typical for that individual)
- Negative thinking

#### Symptoms: Emotional

- Persistent sadness
- Feeling worthless
- Guilt
- Feeling empty
- Feeling hopeless
- Preoccupation or thoughts of death and/or suicide

#### Symptoms: Physical

- Trouble sleeping
- Weight loss or gain
- Low energy
- Extreme fatigue
- Change in eating habits (eating more or less than usual)
- Headache
- Upset stomach

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### Depression

**Symptoms must be persistent and consistent most of the day, nearly every day, and last longer than two weeks before an individual is diagnosed with depression.**

### Treatment: Psychotherapy

**It is important to address depressive symptoms, instead of hoping they will go away.**

- Coined “Talk Therapy”
  - Involves seeing a therapist to talk about depressive emotions and work through them.
  - Therapists can help an individual find the origin/underlying causes of depression and learn coping strategies.
- Cognitive Behavioral Therapy – a type of therapy that targets and shifts unhealthy thought patterns in order to change mood and behavior.

### Treatment: Meditation

- The medial prefrontal cortex (mPFC) can become too active in depressed people. The mPFC, known as the “me center,” processes information about yourself, including worrying about the future and ruminating about the past.
- The “fear center,” known as the amygdala, is another region associated with depression. Responsible for the fight-or-flight response, the amygdala can trigger a cascade of reactions in the body that are perceived as stressful, including rapid heart rate and sweating.
- These two brain regions work closely together in depression. Research has found that meditation weakens the connection between the amygdala and the mPFC.

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## Depression

### Treatment: Antidepressants

**First, to understand how antidepressants work, let's review the basic building block of the brain, the neuron.**

- Cells within the nervous system are called neurons. Neurons are the basic working units in the brain designed to communicate with each other to carry out all brain functions. We have approximately 86 billion neurons in our brains!
- A neuron is made up of three main parts: the dendrites, cell body, and axon. Dendrites receive information from other neurons while axons send information to other neurons via electrical signals. The cell body houses the nucleus and cytoplasm.
- The contact point between two neurons where communication occurs is called the synapse. When a neuron wants to send information, it conducts an electrical impulse down the axon. Something called the myelin sheath wraps around the axon, insulating the axons and allowing the electrical impulse to travel faster. Once the signal reaches the end of the axon, an area called the nerve terminal, chemical messengers called neurotransmitters are released. Neurotransmitters travel across the synapse and bind to receptors on the receiving neuron's dendrites.
- Specific neurotransmitters bind to specific receptors, similar to a lock and key. Binding of the neurotransmitter to its appropriate receptor acts like an on/off switch for the receiving neuron.
- When the signal needs to be stopped, neurotransmitters are cleared from the synapse. This is done by three main mechanisms: 1) enzymes break down neurotransmitters in the synapse; 2) proteins called transporters remove neurotransmitters from the synapse by transporting them back into the presynaptic cell, a process termed reuptake; or 3) neurotransmitters diffuse from the synapse.

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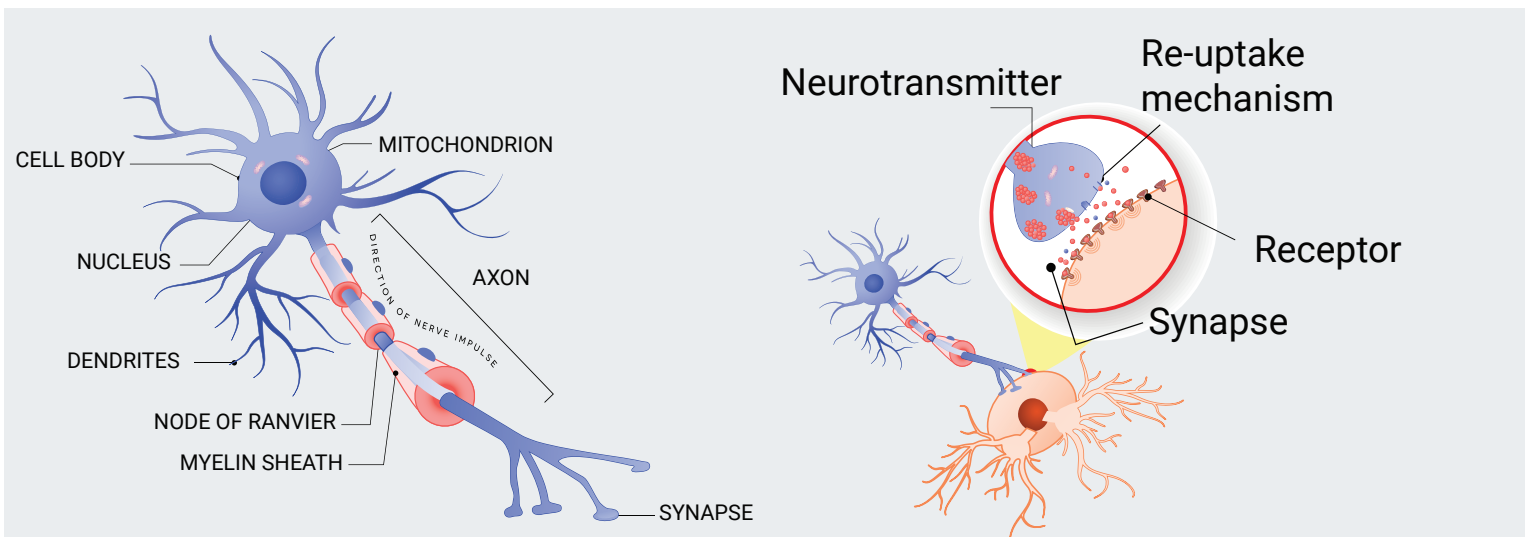
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## Depression

- Selective Serotonin Reuptake Inhibitors (SSRIs)
  - The general theory behind many antidepressants is the more neurotransmitter that is left in the synapse, the greater potential for increased amounts of neurotransmitter received by the post-synaptic cell, which may contribute to improved mood. The re-uptake inhibitor class of these drugs works by blocking the re-uptake of neurotransmitter in the brain, leaving more in the synapse.
  - SSRIs are the most prescribed group of antidepressants.
  - **Examples: fluoxetine (Prozac), sertraline (Zoloft), escitalopram (Lexapro)**
  - Function: SSRIs increase serotonin levels in the brain by inhibiting re-uptake of serotonin.
  - General side effects: drowsiness, nausea, dry mouth, insomnia, diarrhea, nervousness, restlessness, dizziness, headache, blurred vision.
    - Some side effects go away after a few weeks.
    - Fewer side effects compared to other antidepressants.
    - Certain individuals cannot tolerate the side effects of certain SSRIs so these individuals may have to try multiple antidepressants to find which one works best for them.
    - Fluoxetine is the only antidepressant approved for adolescents.



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## Depression

- Serotonin and Norepinephrine Reuptake Inhibitors (SNRIs)
  - **Examples: Cymbalta, Effexor**
  - Function: SNRIs increase levels of both serotonin and norepinephrine in the brain by inhibiting reuptake of these neurotransmitters.
  - Side effects: nausea, drowsiness, fatigue, constipation, dry mouth, insomnia, anxiety, headache, sweating.
- Tricyclic Antidepressants (TCAs)
  - **Examples: Elavil, Norpramin, Asendin**
  - Function: TCAs block re-uptake of serotonin and norepinephrine which increases brain levels of these neurotransmitters. In addition, TCAs block histamine and acetylcholine receptors, which increases the side effect profile for this class of antidepressants.
  - Side effects: blurred vision, constipation, dry mouth, drowsiness, dizziness, weight gain.
    - Less common: irregular heartbeat, seizures, low blood pressure, heart toxicity.
- Monoamine Oxidase Inhibitors (MAOIs)
  - **Examples: Nardil, Parnate**
  - Function: Serotonin, norepinephrine, and dopamine are all in a class of chemicals called monoamines. MAOIs inhibit the enzyme that breaks down monoamines, causing increased levels of serotonin, norepinephrine, and dopamine in the brain.
    - Inhibition of the enzyme MAO is irreversible, which may be dangerous to the patient.



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- Seldom prescribed because MAOIs cause severe reactions when taken with any food that contains the amino acid tyramine.
  - Tyramine is found in dried fruit, cheese, pickles, processed meats, etc.
  - Therefore, there are many dietary restrictions when taking this medication.
- Side effects: nausea, dizziness, restlessness, insomnia, drowsiness, headache, muscle jerks, constipation, dry mouth, anxiety, weight gain.

### Treatment: Atypical Antidepressants

- **Examples: Wellbutrin, Remeron, Oleptro**
- Function: Atypical antidepressants affect serotonin, dopamine, or norepinephrine signaling in unique ways.
- These drugs are grouped together because they do not fit well under any specific class.
- Side effects: dizziness, dry mouth, insomnia, nausea, constipation, weight gain, blurry vision, headache, anxiety, sweating, fast heart rate.

### Treatment: Other Treatment Strategies

- Being active
- Regular sleep schedule
- Spending time with friends and family
- Healthy diet

### Treatment: Dangers of Antidepressant Use

- Can cause increased anxiety when medication is first started (usually goes away with continued use).
- Antidepressants can interact with other drugs (may interfere with the action of other drugs an individual is taking).

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- Antidepressants can cause serotonin syndrome, a condition resulting from too much serotonin signaling in the brain.
  - Symptoms: anxiety, agitation, sweating, confusion, increased heart rate, tremors, restlessness, lack of coordination.
- All antidepressants carry a black box warning, the strictest warning for prescriptions.
  - Although rare, for some, suicidal thoughts may occur at the beginning of treatment when the body is getting used to the drug or a new dose, **especially in children, adolescents, and young adults.**
- Antidepressant withdrawal symptoms: nausea, uneasiness, dizziness, lethargy, flu-like symptoms.
  - **Patients should consult with a doctor on how to properly withdraw from antidepressant medication to avoid these symptoms.**
- There is limited knowledge of the effects of antidepressants in adolescents.
- The best treatment outcomes come from combining treatment strategies.

### Misconceptions

- Someone with depression may not know they have a medical condition due to the self-critical aspect of the disorder. This self-critical mindset leads to the belief that they are a failure, weak, a bad person, a slacker, etc., instead of a person suffering with a mental health disorder.
- Depression can be mistaken for a bad attitude.

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## PROCEDURE

- [1] Each student reads 9th-12th grade Dana Foundation fact sheet, "How Does the Brain Work?"  
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- [2] Give each student a slip of paper and a pencil.  
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- [2] Instructors may wish to set ground rules regarding the discussion of depression and mental health.  
↓
- [3] Ask students to write down the following on a slip of paper:
  - Define depression.
  - Describe the feelings, behaviors, and physical symptoms that are associated with depression.↓
- [4] On a white board (or chalkboard) make three columns labeled "Emotional," "Physical," "Behavioral."  
↓
- [5] Collect students' responses and read them aloud as you write each under the appropriate column.  
↓
- [6] After reading all students' responses, address any items that may be missing from each column.  
↓
- [7] Make a fourth column labeled "Causes." Ask students to think of potential causes that lead to the emotional, physical, and behavioral symptoms of depression.  
↓
- [8] If students identify the brain or biological chemicals as potential causes, use this as a transition to the next topic. If not, start a discussion about how events in an individual's life or an imbalance of chemicals in the brain called neurotransmitters can cause depression.
  - Explain why depression is usually treated by both therapy and drugs that target specific neurotransmitters in the brain.↓
- [9] Split the class into two research groups.

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## PROCEDURE

- [10]** Provide articles (listed at the end of the lesson plan under “Research Articles”) to students.
- Each student should receive the article listed under “Introduction to Depression.”
  - Based on the number of students in each group, provide the appropriate number of copies of the articles recommended for Group 1 and Group 2.
    - Students in each group are encouraged to split up the work by focusing on one article and bringing their knowledge of that article to the group.
    - Group 1 will research the chemical causes of depression.
      - Guiding questions: What symptoms of depression may be caused, at least in part, by chemical changes in the brain? What other factors may cause depression?
    - Group 2 will research how antidepressants work in the brain to help alleviate the symptoms of depression.
      - Guiding questions: What are a few examples of antidepressants? SSRIs are the most often prescribed antidepressants. How do SSRIs affect the brain and how does this decrease the symptoms of depression?



- [11]** Each group will present their research on a poster board. Provide a poster board and markers to each group.



- [12]** Poster Guidelines
- Identify and define key relevant terms, including (but not limited to) depression, neurons, neurotransmitters, receptors, axons, synapses, reuptake, and serotonin. Pictures are welcome!



- [13]** Have each group present their poster. Students are encouraged to take notes that will aid in their homework assignment.



- [14]** After the presentations proceed into a wrap-up discussion.
- Discussion questions:
    - Have you learned anything that surprised you?
    - Do you think most people today understand depression correctly? What are some misconceptions?
    - Do you think educating people on the underlying causes and treatments for depression is important? What are some benefits of this type of education?
    - Do you think it's important to provide multiple treatment options to patients such as SSRIs combined with therapy? If so, why?

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## PROCEDURE

### [15] Homework Assignment

- Each student will create their own pamphlet on teen depression.
- Guidelines
  - Accurate description of the chemical, genetic, and circumstantial causes of depression.
  - A list of treatment options for teens with depression.
  - Caveats or potential issues with these options that the public should be aware of.
  - Pamphlet should be accurate, informative, and visually pleasing.

## RESEARCH ARTICLES

The following articles should be provided to students during the group research phase of the lesson plan procedure:

- Article for Everyone to Read as Background
  - Introduction to Depression  
<https://www.nimh.nih.gov/health/publications/teen-depression/index.shtml>
- Articles for Group 1
  - 4 Ways Depression Can Physically Affect the Brain  
This article describes multiple ways that changes in the brain can lead to depression.  
<https://www.healthline.com/health/depression-physical-effects-on-the-brain#1>
  - What Causes Depression? Brain Chemistry and Neurotransmitters Play Major Roles  
This article describes changes in neurochemical signaling that can lead to depression.  
<https://universityhealthnews.com/daily/depression/what-causes-depression/>
- Articles for Group 2
  - The 5 Major Classes of Antidepressants  
This article describes in detail the 5 major classes of antidepressants including how they function in the brain, examples of each, side effects, etc.  
<https://www.verywellmind.com/what-are-the-major-classes-of-antidepressants-1065086>
  - The Mechanism of Action of Selective Serotonin Re-uptake Inhibitors (SSRIs)  
This brief illustration explains how SSRIs work in the brain at the cellular level.  
<https://institute.progress.im/en/content/mechanism-action-selective-serotonin-re-uptake-inhibitors-ssris>
  - Selective serotonin reuptake inhibitors (SSRIs)  
MayoClinic.Org SSRI Information  
<https://www.mayoclinic.com/health/ssris/MH00066>
- Other Useful Articles
  - This article outlines why cognitive behavioral therapy can be an effective treatment for depression.  
<https://www.healthline.com/health/depression/cognitive-behavioral-therapy#risks-of-cbt>

This lesson plan has been loosely adapted from the New York Times Learning Network Lesson Plan entitled "This is your brain on drugs" by Elizabeth Weaver, M.S., and Katie Partrick, Ph.D., for the Dana Foundation.