

Fear: Body Alert!

Core Concepts

- The brain interprets sensations and triggers fight-or-flight responses.
- The fight-or-flight reactions prepare the body for vigorous physical activity needed for defense (fight) or escape (flight).
- The sympathetic nervous system rapidly conducts nerve signals to many body systems to trigger short term changes that prepare the body for vigorous physical activity.
- The brain also signals endocrine glands to release hormones (chemical messengers), such as adrenaline and cortisol, that result in more widespread and longer lasting fear responses.
- The parasympathetic nervous system restores a relaxed state to maintain homeostasis.
- Stress (a prolonged fear response) may result in health problems.

Class time required:

Approximately 2 forty minute class periods.

Teacher Provides:

For each student

- Copy of student handout entitled **Fear: Body Alert!**

For Part 1 each team of 2-4 students will need:

- Bag containing:
 - Small plastic bag with 1 set of **Fight-or-Flight / Relax** cards (page iv). Consider laminating and/or printing on card stock for use by multiple classes.
 - 2 envelopes. Label one “Fight-or-Flight” and the other “Relax”

For Part 2 each team of 2-4 students will need:

- 1.5 mL microtubes or other small tubes prepared as shown in the chart below:

Label on Tube	Contents of Tube – 1 mL of
Immediately before	pH 4 buffer
1 minute after	pH 9 buffer
10 minutes after	pH 7 buffer
Adrenaline Test Solution	0.01% Bromothymol blue solution

- Plastic droppers labeled:
 - Immediately before
 - 1 minute after
 - 10 minutes after
 - Adrenaline Test Solution
- **Hormone Test Sheet** (page v) printed on plastic transparency
- Small bag labeled “Cortisol Test Paper” containing at least 5 small pieces (cut paper into pieces that are about ¼ inch long) of pH 1-12 test paper.
- **Adrenaline and Cortisol Color Charts** (page vi). Consider laminating for use by multiple classes.

For Part 3 each team of 2-4 students will need:

- 1 color copy of the **Sympathetic and Parasympathetic Nervous System** diagram.
Tape (optional) for attaching cards to poster.
- Access to computers (optional)

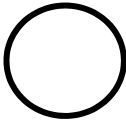
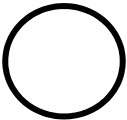
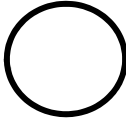
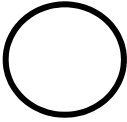
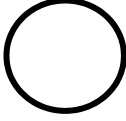
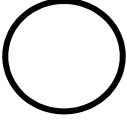
Suggested Class Procedure:

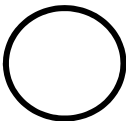
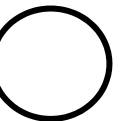
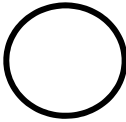
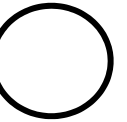
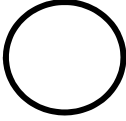
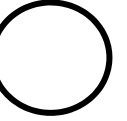
1. Assign the **Introduction** (pages 1 and 2) of **Fear: Body Alert** for homework.
2. Begin class by asking several students to read their answers from the homework. Note that there is variation in the things that frighten different people because people can learn to be afraid of situations. There is much less variation in the responses most people's bodies make to frightening situations. That is because people are "wired" to make the same unlearned responses to fear emotion.
3. Assign students to work in pairs. Distribute one of the following to each pair of students:
 - **Sympathetic Nervous System and Parasympathetic Nervous System** diagram
 - Set of **Fight-or-Flight / Relax** cards (copy page 4 and cut into cards)
 - Fight-or-Flight and Relax envelopes
4. Students work in pairs to complete the **Fear: Body Alert** activity.
5. Distribute the following materials to each team when students begin Part 2.
 - Droppers and tubes labeled:
 - Immediately before
 - 1 minute after
 - 10 minutes after
 - Adrenaline Test Solution
 - **Hormone Test Sheet**
 - Small bag of "Cortisol Test Paper"
 - **Adrenaline and Cortisol Color Chart**
6. For further (optional) exploration, students may:
 - Visit the *Goosebumps: The Science of Fear* website at <http://www.fearexhibit.org/>
 - Visit How Stuff Works: Fear at <http://science.howstuffworks.com/life/fear.htm>

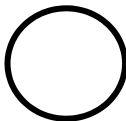
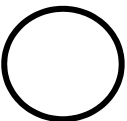
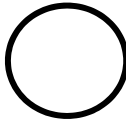
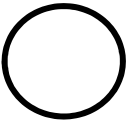
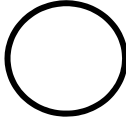
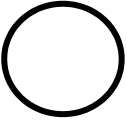
Ask students to list the 5 most interesting things that they learned about the biology of "fear." Allow time for them to share their lists with their classmates.

Fight-or-Flight / Relax Cards: *Cut out, shuffle, and place in plastic bag*

Muscles tense	Muscles relax
Heart rate increases	Heart rate decreases
Airway tubes to lungs dilate (open)	Airway tubes to lungs constrict (close)
Pupils of eyes dilate (open) to increase the amount of light entering the eye	Pupils of eyes constrict (close) to decrease the amount of light entering the eye
Digestive system movement and enzyme secretion decreases	Digestive system movement and enzyme secretion increases
Blood vessels to muscles and lungs dilate (open)	Blood vessels to muscles and lungs constrict (close)
Blood vessels to skin, brain, and digestive system constrict (close)	Blood vessels to brain, skin, and digestive system dilate (open)
Sweat glands release more perspiration	Sweat glands release less perspiration
Breathing rate increases	Breathing rate decreases

Hormone Test Sheet	Adrenaline Test	Cortisol Test
Immediately before frightening noise		
1 minute after frightening noise		
10 minutes after frightening noise		

Hormone Test Sheet	Adrenaline Test	Cortisol Test
Immediately before frightening noise		
1 minute after frightening noise		
10 minutes after frightening noise		

Hormone Test Sheet	Adrenaline Test	Cortisol Test
Immediately before frightening noise		
1 minute after frightening noise		
10 minutes after frightening noise		

Adrenaline Test Color Chart		Cortisol Test Color Chart	
Adrenaline Level	Color	Cortisol Level	Color
0	Yellow	0	Orange
10	Light Green	10	Dark Green
20	Brown	20	Blue
30	Red	30	Magenta
40	Pink	40	Light Yellow
50	Blue	50	Grey

Adrenaline Test Color Chart		Cortisol Test Color Chart	
Adrenaline Level	Color	Cortisol Level	Color
0	Yellow	0	Orange
10	Light Green	10	Dark Green
20	Brown	20	Blue
30	Red	30	Magenta
40	Pink	40	Light Yellow
50	Blue	50	Grey

Adrenaline Test Color Chart		Cortisol Test Color Chart	
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10	Light Green	10	Dark Green
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30	Red	30	Magenta
40	Pink	40	Light Yellow
50	Blue	50	Grey

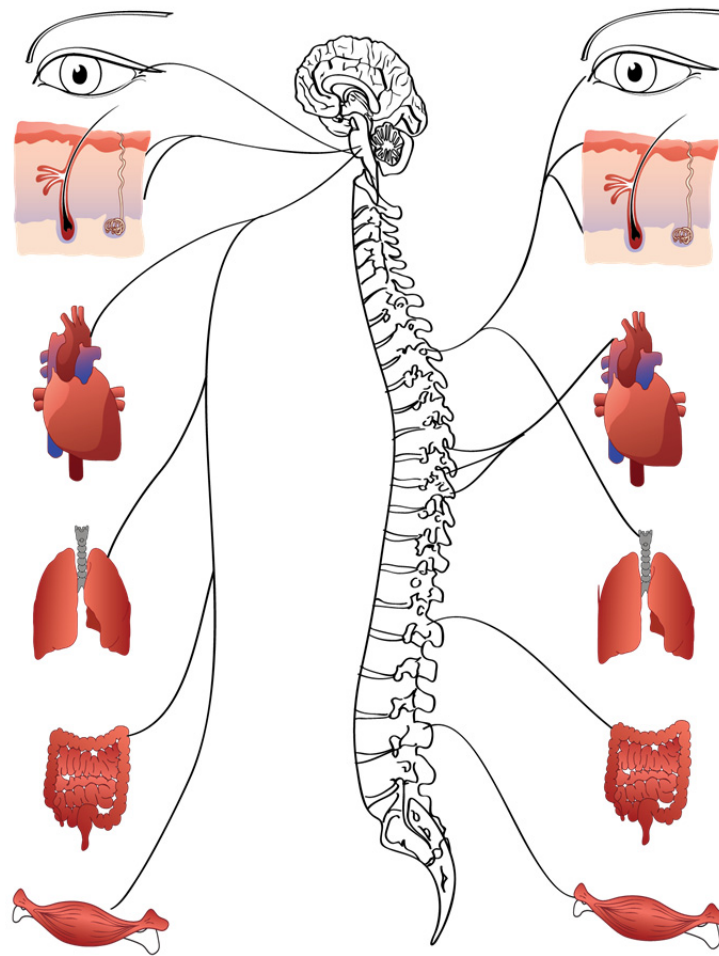
Adrenaline Test Color Chart		Cortisol Test Color Chart	
Adrenaline Level	Color	Cortisol Level	Color
0	Yellow	0	Orange
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Adrenaline Test Color Chart		Cortisol Test Color Chart	
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20	Brown	20	Blue
30	Red	30	Magenta
40	Pink	40	Light Yellow
50	Blue	50	Grey

Parasympathetic Nervous System

Sympathetic Nervous System



Fear: Body Alert!

Introduction

Fear: A distressing emotion aroused by impending danger, evil, pain, etc., whether the threat is real or imagined.

Synonyms: foreboding, apprehension, consternation, dismay, dread, terror, fright, panic, horror, trepidation, qualm.



1. List at least four things or situations that trigger your fear response.

-
- ***Student answers will vary and may include both things (spiders, snakes, insects, etc.) or situations (taking a test, giving a speech, visit to a dentist or doctor. etc.)***
-
-

2. List at least four changes that occur in your body when you respond to a frightening situation.

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- ***Student answers will vary but may include increased heart rate, breathing rate, sinking feeling in stomach, goose bumps, muscle tension, etc.***
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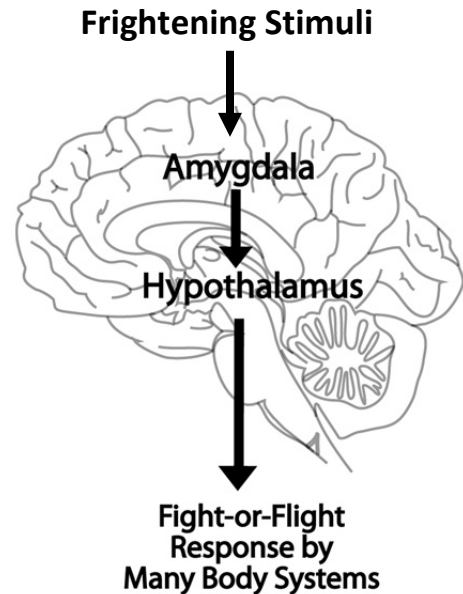
Part 1: Fear and the Nervous System

Fear and the Fight-or-Flight Response

Fear is a chain reaction in the brain that happens when you encounter a potentially harmful stimulus. The amygdala is the part of your brain that receives information from many parts of the brain and interprets this information to generate the emotion of fear. When the amygdala generates a fear emotion, it sends impulses to another part of the brain, the hypothalamus.

The hypothalamus then sends impulses to many different parts of the body to trigger a fight-or-flight response. During the fight-or-flight response, many body systems undergo changes to give your body a burst of energy needed to defend yourself (fight) or to escape (flight) in a potentially harmful situation.

Fight-or-flight responses are unlearned reactions that humans and many other animals automatically make to increase their chances for survival in a potentially dangerous situation. Organisms that feared the right things and made a fight-or-flight response were more likely to survive and pass on their genes to their offspring.



3. What is the purpose of fear and the fight-or-flight response?

They increase an organism's chances for survival in a potentially dangerous situation.

4. Explain why people do not need to be taught to make a fight-or-flight response.

It is an unlearned response that happens automatically.

5. What part of the brain would best be called the "fear emotion center"?

The amygdala

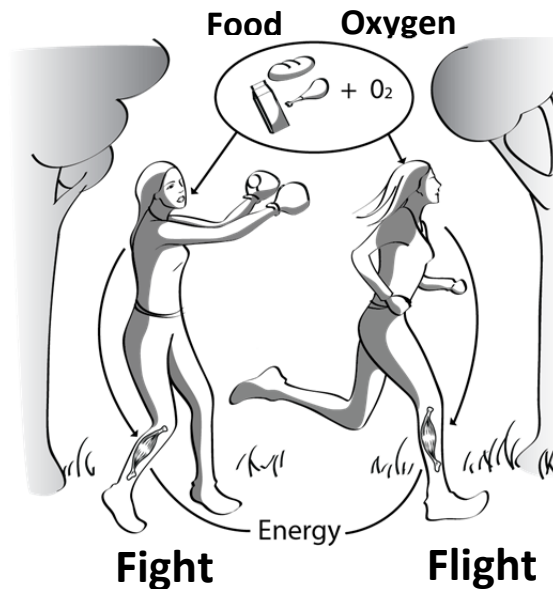
6. What part of the brain sends signals to many different parts of the body to make the fight-or-flight response?

The hypothalamus

Fight-or Flight Response

During the fight-or-flight response, many body systems undergo changes to give your body a burst of energy and the strength needed to defend yourself or to run away from a dangerous situation.

Both fight and flight require food and oxygen for cellular respiration that provides the energy for vigorous muscle activity.



The fight-or-flight response:

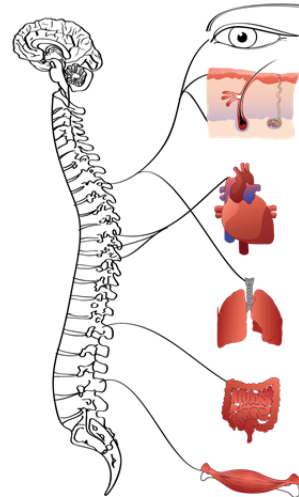
- **Stimulates** (increases) the activities of parts of the body necessary for vigorous muscle activity such as the circulatory system and respiratory system. These systems increase the delivery of oxygen and food to muscles. Cellular respiration in the muscle uses the oxygen and food to provide energy for fighting or running.
- **Inhibits** (decreases) the activities of parts of the body that are not immediately essential for fighting or running, such as the digestive system, the immune system, the urinary system, and the reproductive system.

7. Your lab kit contains a bag of 18 cards. Use the information in the reading above to sort the cards into two piles.
 - **FIGHT-or-FLIGHT** responses needed to prepare the body for the vigorous muscle activity essential for fighting or running
 - **RELAX** responses needed to return to normal
8. Save the two separate piles of cards!!! Put them into the envelopes labeled “Fight-or Flight” and “Relax.” You will need both piles of cards later in this lab activity.

The sympathetic nervous system

To get messages to many different parts of the body, the hypothalamus sends impulses through the **sympathetic nervous system**. The sympathetic nervous system is composed of branching nerves which are connected to many different parts of the body.

Nerve impulses travel very rapidly through the branches of the sympathetic nervous system. The effect of the sympathetic nervous system on body systems is very rapid but relatively brief.



9. Use the **Sympathetic Nervous System** diagram in your kit. This diagram shows the branching nerves in the sympathetic nervous system and the parts of the body that receive signals during the fight-or-flight response.
10. Place the FIGHT-or-FLIGHT cards on the side of the diagram labeled “Sympathetic Nervous System” to indicate how the parts of the body respond to nerve impulses traveling over the sympathetic nervous system. *Hint: some of the cards could be placed on several different organs. Place the card on one of the related organs.*
11. Ask your teacher to check your work. Teacher initials _____
12. List four of the fight-or-flight responses (from the cards) in the first column of the chart below. Then complete the chart by describing how each response is important for preparing the body for vigorous muscle activity. Be specific!

Fight-or-Flight Responses	How does this response prepare the body for the vigorous physical activity needed for running or defending yourself?
<i>Increased sweating</i>	<i>Cools the body</i>
<i>Increased heart beat rate</i>	<i>Pumps blood more rapidly so that more food and oxygen are delivered to the muscles.</i>
<i>Increased breathing rate</i>	<i>Delivers more oxygen to the blood so that it can be delivered to muscles</i>
<i>Constricts blood vessels to the skin, brain, and digestive system</i>	<i>Shifts blood to the muscles</i>

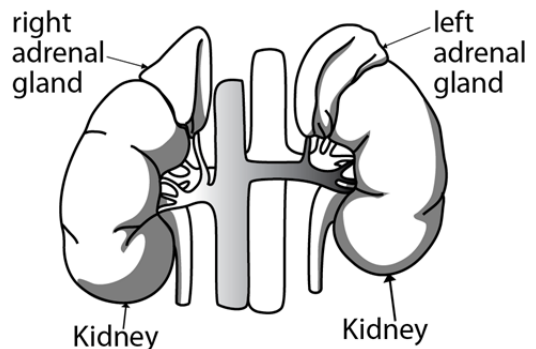
Part 2: Fear and the Endocrine System

Fear Hormones

The other way to get messages to many different parts of the body is through hormones (chemical messengers) secreted by the endocrine system. The adrenal gland is an endocrine gland that produces two fear hormones—adrenaline and cortisol. These hormones are carried in the bloodstream to all parts of your body.

Fear hormones are secreted by the adrenal gland, an endocrine gland located on top of your kidneys. The fear hormones circulate through the bloodstream to all cells of your body.

The effect of adrenaline (also called epinephrine) is similar to the effect of the sympathetic nerve action. Adrenaline increases heart rate, increases breathing rate, dilates blood vessels to the lungs and muscles. Adrenaline also decreases blood flow to the brain and decreases digestion.



Cortisol increases blood sugar level by converting stored glycogen and fats into blood sugar. Cortisol also suppresses the immune response and inflammation.

Fear hormones result in a longer lasting and more widespread fight-or-flight response than the effects of the nervous system. Fear hormone action explains why you may feel the fight-or-flight response even after you realize there really is no danger.

1. What endocrine glands produces and secretes fear hormones—adrenaline and cortisol?

Adrenal glands

2. The fear hormones, adrenaline and cortisol, can be detected in the blood plasma (liquid part of the blood). Your lab kit contains samples of simulated blood plasma collected from the same person at three different times:
 - Immediately before a loud, frightening noise
 - 1 minute after a loud, frightening noise
 - 10 minutes after a loud, frightening noise

Place 1 drop of each of the blood plasma samples in both circles of the appropriate **rows** on the Hormone Test Sheet.

Hormone Test Sheet	Adrenaline Test	Cortisol Test
Immediately before noise	<input type="checkbox"/>	<input type="checkbox"/>
1 minute after noise	<input type="checkbox"/>	<input type="checkbox"/>
10 minutes after noise	<input type="checkbox"/>	<input type="checkbox"/>

- Add 1 drop of Adrenaline Test Solution to both of the circles in the Adrenaline Test **column**. Use the Adrenaline Color Chart to determine the levels of adrenaline. Record the data you collect on the table below.
- Add 1 strip of Cortisol Test Paper to both of the circles in the Cortisol Test **column**. Use the Cortisol Color Chart to determine the levels of adrenaline. Record the data you collect on the table below.

Time Sample was collected	Adrenaline Level (micrograms/100 ml)	Cortisol Level (micrograms/100 ml)
Immediately before noise	0	0
1 minute after noise	50	10
10 minutes after noise	10	40

- Wash and dry the Hormone Test Sheet.
- Based on the information in the data table:
 - Which hormone (adrenaline or cortisol) is secreted most rapidly after a frightening event?

Adrenaline

- Which hormone (adrenaline or cortisol) remains in the bloodstream for a longer time?

Cortisol

Base your answers to questions 7 through 10 on the information in the *Fear Hormones* reading.

- Circle the appropriate words on the right to indicate how **adrenaline** (also called epinephrine) would affect each of the following:

Heart rate	<u>increases</u>	decreases
Breathing rate	<u>increases</u>	decreases
Airways that lead to lungs	<u>dilates</u>	constricts
Digestion	increases	<u>decreases</u>

8. Adrenaline increases breathing rate and opens the airways to the lungs. Explain why this is important for the vigorous muscle activity needed for a fight-or-flight response.

This increases the amount of oxygen in the body. Oxygen is needed for cellular respiration that produces energy for muscle activity.

9. Cortisol elevates blood glucose (sugar) level. Explain why this is important in a frightening situation.

Muscles need glucose to make ATP (or energy) needed for muscle activity.

10. Adrenaline increases heartbeat rate and dilates (opens) blood vessels to the muscles. Explain why this is important for the vigorous muscle activity needed for a fight-or-flight response.

This increases the flow of blood to muscles so that they can get the food and oxygen they need for cellular respiration that produces energy for muscle activity.

11. Circle the hormone that is most closely associated with each of the following statements:

This hormone may be used as a medication to reduce inflammation, allergic reactions, and diseases in which the immune system attacks the body.	Adrenaline (also called epinephrine)	<u>Cortisol</u>
This hormone may be used as a medication when the heart stops beating or when an allergic reaction closes off airways.	<u>Adrenaline</u> (also called epinephrine)	Cortisol
During periods of prolonged starvation, this hormone is secreted to maintain blood sugar levels.	Adrenaline (also called epinephrine)	<u>Cortisol</u>

12. Compare the nervous system and the endocrine system response to a frightening situation.

- Which is faster? ***Nervous system***
- Which is longer lasting? ***Endocrine system***
- Which has a more widespread effect? ***Endocrine system***

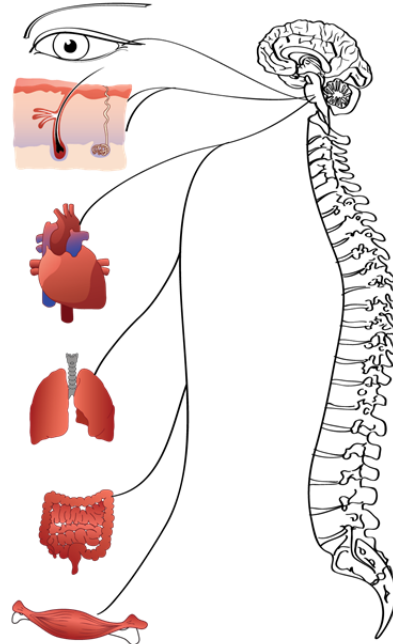
Part 3: How do you recover from a fear response?

The parasympathetic nervous system

Your body cannot maintain a prolonged fight-or-flight response. After an individual has fought or fled a dangerous situation, their body needs to shut down the fight-or-flight response and return to normal.

The reversal of the fight-or-flight response is caused by the actions of the parasympathetic nervous system.

The **parasympathetic nervous system** consists of branching nerves that carry nerve impulses to many parts of the body. It causes the body to restore homeostasis (a balanced state) by relaxing and restoring basic life processes needed for maintaining health.



13. Place the RELAX cards on the side of the diagram labeled “Parasympathetic Nervous System” to indicate how the parts of the body respond to nerve impulses traveling over the parasympathetic nervous system. *Hint: some of the cards could be placed on several different organs. Place the card on one of the related organs.*

14. Ask your teacher to check your work. Teacher initials _____

15. What do the body changes triggered by the parasympathetic nervous system have in common?

They return the body to the normal relaxed state and/or they restore homeostasis.

16. Compare the action of the parasympathetic and the sympathetic nervous system.

They have opposite effects on the body.

Part 4: What is Stress?

Read the information below about health problems that may result from chronic stress. As you read, underline health problems that may be associated with chronic stress.

Stress and Your Health

Daily life can involve many stimuli that are perceived as threatening. Problems at work or at school, money or social problems, and medical problems can trigger a chronic (long term) fight-or-flight response. Even anticipating (worrying about) things that might happen in the future can trigger the same response as actually experiencing it.

Chronic stress occurs when the fight-or-flight response does not shut down to allow for the proper balance between fear and relaxation. Stress can increase a person's risk of health problems.

The fight-or-flight response uses calories so the urge to eat makes sense after running. But, eating in response to daily stresses can lead to weight gain. In addition, stress increases cortisol levels causing elevated blood sugar levels that can lead to both weight gain and diabetes.

When the fight-or-flight response causes blood pressure and heart rate to remain high, it puts extra strain on blood vessel walls. As a result, the linings of blood vessels can become damaged. An interruption of blood flow to the heart can lead to a heart attack. Blood vessels in the brain can also be blocked, resulting in brain-damaging strokes.

People suffering from stress secrete cortisol at much higher rates than normal people. There is evidence that abnormally high cortisol levels may actually be the initial trigger for depression in some individuals. High cortisol levels also result in sleep deprivation (lack of normal amounts of sleep).

Stress also affects the function of the immune system, the body's natural means of fighting off infection. Stressed individuals produce lower levels of antibodies when exposed to pathogens. They also produce higher levels of cytokines, inflammation triggering chemicals secreted when fighting infections. Excessive inflammation is thought to increase the risks for heart disease, diabetes, and some forms of cancer.

Feeling stressed mentally and physically may have serious health consequences. It is important to consult a mental health care provider to discuss the causes of your stress and learn about specific actions you can take to reduce stress.

1. How would YOU define “chronic stress”?

Long term fight-or-flight responses by the body

2. List two examples of things or situations YOU find stressful?

Student answers will vary.

3. What hormone seems to be responsible for most of the negative health effects of stress?

Cortisol

4. List at least five potential negative health effects of stress.

Weight gain, heart attacks, heart disease, strokes, inflammation, decreased ability to fight disease, sleep disturbances, diabetes, and depression.

5. List at least five **positive** actions that people could take to relax and reduce stress.

Student answers will vary. Have students share their ideas for stress reduction actions. BUT caution them that these must be “positive and socially acceptable.” Sex, drugs, and alcohol are not positive actions.