

Diverging Identical Twins

Overview of Lesson Plan: Introduce students to epigenetics and how an individual's genome responds to his or her environment.

Big Understanding: The epigenome is a set of chemical switches and markers that influence gene expression. Diet, environmental stressors, physical activity, and exposure to toxins can activate these chemical switches that regulate gene expression without changing the underlying genetic code. Epigenetics is the study of changes in gene activity that do not involve changes to the genetic code.

Essential Questions: Identical twins are genetic carbon copies, meaning their DNA sequencing is the same. Yet physically they become increasingly different over time. Why is this so?

Grades: 5-8

Subjects: General

Time required: 45 minutes

Objectives: Epigenetics can lead to increasing differences in identical twins over time

Materials: Teacher instruction and [student handout "Diverging Twins"](#)

Preparation: Listed below is basic background information on how diet, physical activity, and stress interact with the epigenome:

- **DIET** - The nutrients the body extracts from food enter metabolic pathways where they are manipulated, modified and molded into molecules the body can use. One such pathway is responsible for making methyl groups - important epigenetic tags that silence genes.
- **STRESS** - Chemicals released in the body in times of stress interact with the epigenome. Many studies are focusing on the effect of the stress hormone *cortisol*, and how it influences epigenetic tags and thus gene expression.
- **PHYSICAL ACTIVITY** - While the overall effect of physical activity on the epigenome is not yet fully understood, there is evidence that hormones produced during physical activity may change epigenetic tags and thus gene expression.
- **EXPOSURE TO TOXINS** – These are potentially harmful substances that include alcohol, smoking and exposure to pesticides, air pollutants, and harmful metals such as lead and nickel and can influence epigenetic tags and thus gene expression.

Activities/Procedures:

1. Review the connections and interactions DIET, PHYSICAL ACTIVITY, STRESS, and TOXINS has on an individual epigenome. Have students work together guessing and matching the terms with the descriptions. Review answers as a group.
2. Divide the class into two groups. Inform students that each group will collectively represent one of the identical twins. Then have the class determine if the twins will be identical girls or boys.
3. Provide each student with a "Diverging Twins" handout to record the life experiences of each twin and reflect on the overall impact.
4. At each age, have one student from each group pick a number 1-6. The number will correspond with specific event listed in the Teacher's Guide.
5. Students need to record the number and the chosen event on their "Diverging Twin" handout.

Assessment/Reflection: Listed below the **Age 77** part of the Teacher's Guide and Student Handout



Diverging Twins – Teacher Guide

Note to teacher: It is important that all students are familiar with the following concepts before beginning the activity on how identical twins change physically over time.

- Identical twins are genetic carbon copies, meaning their DNA sequencing is the same. Yet physically they become increasingly different over time.
- Why is this so?
- Genes are the instruction manual for the development and maintenance of the body
- The epigenome is a second set of instructions interacting with DNA that activate or suppress the expression particular genes
- Epigenetics is the study of changes in gene activity that do not involve changes to the genetic code



Directions: Have students pick a number 1-6 for each age (3, 8, 16, 25, and 40) and have them record the event on their “Diverging Twins” worksheet

At birth – Identical twins share the same environment and their epigenome are very similar at birth. Signals in the twins’ environment activate and silence genes without changing the underline genetic code.

Age 3

1. Loves to eat broccoli and spinach
2. Refuses to eat raw vegetables due to getting sick after eating carrots
3. Is afraid of dogs after being bitten in the face by the family’s dog after pulling its tail
4. You were bitten by a tick and developed Lyme disease
5. You just came down with chicken pox
6. Parents can’t afford to provide you with daily vitamins

Age 8

1. Enjoys reading everyday
2. Swims three days a week
3. Likes to play soccer
4. Always eats oatmeal for breakfast
5. Is very good at playing computer games
6. Drinks orange soda everyday

Age 16

1. Started smoking
2. Runs Cross-Country
3. Drives everywhere and refuses to wear a seat belt
4. Has been on a celery only diet for the last six weeks
5. Is being bullied by ex-best friend
6. Addicted to potato-chips and cola

Age 25

1. Married with a one-year-old and a full-time job
2. Drinking heavily in an effort to fall asleep after working swing-shift
3. Walks two miles every morning before going to work
4. Is really into organic gardening and raising chickens
5. Spends much of his or her free time on various social networks and gaming
6. Eats regularly at fast food restaurants because cooking a meal takes too much time.

Age 40

1. Eats a whole grain muffin with yogurt every morning for breakfast
2. Going through a divorce
3. Drinks 3+ glasses of wine in the evening
4. Eats out at least five days a week
5. Lost job and might need to file for bankruptcy
6. Takes dog for a two-mile walk every evening

Age 55

1. Recently diagnosed with Type-2 diabetes
2. Eats dark leafy green vegetables such as spinach and kale four times a week
3. Is working two jobs to help put children through college
4. Smoking a pack of cigarettes a day
5. Drinks a chocolate mocha with whip cream everyday

Age 77 – *Answer the following questions about your twin based on their life events*

1. What events had little or no impact on his/her epigenetically?
2. Were there events that made the twin more vulnerable to chronic disease? Explain
3. What is his or her level of physical activity?
 - a. Is he/she able to be active and involved in outdoor activities?
 - b. Is he/she unable to be active and thus living a sedentary lifestyle?
4. Describe his or her overall physical health
5. What life events could he or she have changed to increase his or her health at this age?

Diverging Twins – Student Handout

- Identical twins are genetic carbon copies, meaning their DNA sequencing is the same. Yet physically they become increasingly different over time.
- Why is this so?
- Genes are the instruction manual for the development and maintenance of the body
- The epigenome is a second set of instructions interacting with DNA that activate or suppress the expression particular genes
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Draw a line matching the terms with description of how they interrelate with epigenetics

DIET

While the overall effect of physical activity on the epigenome is not yet fully understood, there is evidence that hormones produced during physical activity may change epigenetic tags and thus gene expression.

PHYSICAL ACTIVITY

Chemicals released in the body in times of stress interact with the epigenome. Many studies are focusing on the effect of the stress hormone cortisol, and how it influences epigenetic tags and thus gene expression.

STRESS

These are potentially harmful substances that include alcohol, smoking and exposure to pesticides, air pollutants, and harmful metals such as lead and nickel and can influence epigenetic tags and thus gene expression.

TOXINS

The nutrients the body extracts from food enter metabolic pathways where they are manipulated, modified and molded into molecules the body can use. One such pathway is responsible for making methyl groups - important epigenetic tags that silence genes.

On the space below record the life events that occur to your twin throughout his/her life

At birth – Identical twins share the same environment and their epignome are very similar at birth. Signals in the twins’ environment activate and silence genes without changing the underline genetic code.

Age 3: # _____

Age 8: # _____

Age 16: # _____

Age 25: # _____

Age 40: # _____

Age 55: # _____

Age 77 – Answer the following questions about your twin based on their life events

1. What events had little or no impact on his/her epigenetically? _____

2. Were there events that made the twin more vulnerable to chronic disease? Explain _____

3. What is his or her level of physical activity? _____
 - a. Is he/she able to be active and involved in outdoor activities? _____

 - b. Is he/she unable to be active and thus living a sedentary lifestyle? _____

4. Describe his or her overall physical health. _____

5. What life events could he or she have changed to increase his or her health at this age? _____

6. Draw a picture of your identical twin based on his/her life experiences that influenced his/her epigenome over his/her lifetime. Then get together with a student that is a representative of the other twin. After hearing about that twins life experiences, draw a picture of what you imagine that twin looking like.

Your twin: _____

Other twin: _____

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