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Exploring Epigenetics through Art

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Exploring Epigenetics through Art

Life experiences and environmental conditions can influence the way our genes express themselves and impact our future behavior. Students will gain an understanding of how different experiences during pregnancy impact the neurodevelopment of children by studying the placenta-brain-axis.

Suggested duration

- 2 x 45 min class period

Essential questions

- What is the relationship between the pregnant parent, the placenta, and the fetus?
- How can life experiences during pregnancy impact the neurodevelopment of the fetus?
- How can we use art to better understand complex scientific concepts?

Objectives

Overall STEM goal: Genes can be expressed or repressed due to different life experiences.

All students will...

- Understand the structure and function of the placenta and its role during pregnancy.
- Analyze how life experiences during pregnancy can affect the neurodevelopment of the fetus.
- Design a piece of artwork that demonstrates the relationship between the pregnant parent, the placenta, and the fetus in neurodevelopment.
- Justify the inclusion of artistic elements and symbols in their artwork by explaining how they represent the placenta-brain-axis.

Materials

- Markers or colored pencils
- File Folder
- Smartboard or projector

Supplementary Materials

- Epigenetics as Art Powerpoint
- Epigenetics as Art Student Worksheet
- Epigenetics as Art Student Worksheet (Modified)
- Epigenetics as Art Supplementary Materials (Accountable Talk Stems, Test-Taking Strategies, Graphs)

Based on

The Stavros Niarchos Brain Insight Lectures

- “Art in the Brain of the Beholder” By Amanda Phingbodhipakkiya and Nikolaus Kriegeskorte, Ph.D.
- "Nature and Nurture: How Our Experiences Shape the Brain Across Generations" By Bianca Jones Marlin, Ph.D., and Yasmin Hurd, Ph.D.

Instructional Activities

Class 1:

1. Warm-Up | 10min

Use Epigenetics as Art Student Worksheet and Epigenetics as Art Student Worksheet - Modified as needed. Use Epigenetics as Art Powerpoint to project on the board.

During the first five minutes of class, have the students silently and independently look at the image provided under the warm-up section of their worksheets. They should write down three things they see in the image, three conclusions they can draw from the image, and three questions they still have about the image.

After five minutes of independent work time, annotate the learning objective with the students using the following questions:

- What is some of the science vocabulary in the learning objective?
  - Circle the words and have the students work towards a definition of the new vocabulary in black.
- Based on the learning objective, what are we going to do today?
  - Circle the verbs and underline the activities in green.
- Based on the learning objective, what are we going to learn about today?
  - Underline the concepts students will be learning about in blue.

After annotating the learning objective, ask the students what some of the things were that the students saw in the image and write them down on the warm-up projected on the board. Based on what the students saw in the image, ask them what conclusions they could draw from the image. Some prompting questions could be:

- Based on the image, what is the function of the umbilical cord during pregnancy?
- Based on the image, what is the role of the placenta during pregnancy?
- Based on your knowledge of biology, what nutrients and/or gasses might the fetus receive from the parent's blood?
- Based on your knowledge of biology, what process would allow those nutrients and/or gasses to pass from the pregnant parent to the fetus?

Write down the students' conclusions on the board. Finally, ask the students what remaining questions they may have about the relationship between the fetus, placenta, and the pregnant parent and write them on the board.

2. New Vocabulary | 5min

Use Epigenetics as Art Student Worksheet and Epigenetics as Art Student Worksheet- Modified as needed. Use the Epigenetics as Art Powerpoint to project on the board.

Have the students write down the vocabulary words provided on Slide 3 and Slide 4 of the Epigenetics as Art Powerpoint in the corresponding spaces on their Epigenetics as Art Worksheets.

3. Think, Ink, Link Protocol | 20min

Use Epigenetics as Art Student Worksheet and Epigenetics as Art Student Worksheet- Modified as needed.

Before the lesson, pre-arrange student desks into groups of five. Place a copy of each of the five paragraphs inside of a file folder and place a folder at each of the groups.

During the first ten minutes of this activity, have the students divide the paragraphs among themselves. Students should silently and independently read and annotate their paragraph. After reading their paragraph, they should answer the corresponding questions on their worksheet. While students are completing their paragraphs, the teacher should be circulating and providing feedback on students' responses.

During the next ten minutes of this activity, each student should share their responses with their group members. Group members who are not sharing out should be taking notes on what they are learning from their classmates in the discussion. Students can use the accountable talk stems to agree, disagree, or clarify what their group mates stated. Circulate to each group to provide feedback and clarification as needed. By the end of the activity, every student should have responses for every paragraph's questions.

4. Turn and Talk| 5 min

Use Epigenetics as Art Supplementary Materials for the RACES test-taking strategy for multiple-choice questions and for the Accountable Stems. Best practice is to have these materials taped to students' desks prior to class for easy reference. Use Epigenetics as Art Student Worksheet and Epigenetics as Art Student Worksheet- Modified as needed.

During the first two minutes of this activity, have the students silently and independently answer the Regents-based multiple-choice question and justify their response in the space provided. Remind students to use the RACES test-taking strategy to help them answer the question correctly.

During the next two minutes of this activity, students should turn and talk with their partners about why they chose their answer choice. Remind students of the turn and talk protocol provided on Slide 6 of the Epigenetics as Art Powerpoint. Students can use the accountable talk stems to agree, disagree, or clarify what their group mates stated.

Take one minute to wrap up the activity by providing feedback to the class on what you heard from different pairs that met today's learning objective and provide any necessary clarifications.

5. Exit Ticket| 5 min

Use Epigenetics as Art Supplementary Materials for the RAID test-taking strategy for short-response questions. Best practice is to have these materials taped to students' desks prior to class for easy reference.

Ue Epigenetics as Art Student Worksheet and Epigenetics as Art Student Worksheet- Modified as needed.

For the last five minutes of class, students should be completing the exit ticket, which is a Regents-based short-answer response. Remind students to use the RAID test-taking strategy to help them answer the questions correctly. Collect the worksheet at the end of the period to determine students' understanding of the placenta-brain-axis.

Class 2:

1. Warm-Up | 10min

Use Epigenetics as Art Student Worksheet and Epigenetics as Art Student Worksheet- Modified as needed. Use the Epigenetics as Art Powerpoint to project on the board.

During the first five minutes of class, have the students silently and independently look at the image provided under the warm-up section of their worksheets. The students should complete the short-answer questions reviewing yesterday's lesson about the placenta-brain-axis.

After five minutes of independent work time, annotate the learning objective with the students using the following questions:

- What is some of the science vocabulary in the learning objective?
  - Circle the words and have the students work towards a definition of the new vocabulary in black.
- Based on the learning objective, what are we going to do today?
  - Circle the verbs and underline the activities in green.
- Based on the learning objective, what are we going to learn about today?
  - Underline the concepts students will be learning about in blue.

After annotating the learning objective, ask the students to share their responses to the warm-up questions. For the first question, push the students to make a connection between the life experiences during pregnancy and the development of the fetus. For the second question, ensure the students name what nutrients, gasses, and hormones are exchanged across the placenta through diffusion.

2. New Vocabulary | 5min

Use Epigenetics as Art Student Worksheet and Epigenetics as Art Student Worksheet- Modified as needed.

Use the Epigenetics as Art Powerpoint to project on the board.

Have the students write down the vocabulary words provided on Slide 10 and Slide 11 of the Epigenetics as Art Powerpoint in the corresponding spaces on their Epigenetics as Art Worksheets.

For gene expression, explain the concept to the students using the example provided on the powerpoint, then ask them the following questions to check for understanding:

- If the temperature is primarily 25° during incubation, what sex would the European pond turtles be?
- If the temperature is primarily 30° during incubation, what sex would the European pond turtles be?
- If the temperature is primarily 27° during incubation, what sex would the European pond turtles be?
- Why does the sex ratio of the European pond turtles differ in each of those scenarios?

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For epigenetics, explain the concept to the students using the example provided on the powerpoint, then ask them the following questions to check for understanding:

- What happens to someone's genes when they begin smoking cigarettes?
- What happens to someone's genes when they stop smoking cigarettes?
- Why does this change in gene expression occur?
- What is the relationship between gene expression and epigenetics?

1. Background Information | 8min

Use Epigenetics as Art Student Worksheet and Epigenetics as Art Student Worksheet- Modified as needed.

In groups of four, have students discuss and describe how cannabis use and stress during pregnancy affect neurodevelopment in children after birth by analyzing the three graphs provided. Students should write down their observations and conclusions in the graphic organizer on their worksheets.

While students are working in their groups, circulate and ensure students are making the connection that cannabis use and stress negatively impact fetal development and child behavior (increased likelihood of anxiety, aggression, hyperactivity, and stress) to varying degrees.

2. Visual Representation of Stress and Cannabis Use on Gene Expression | 10min

Use Epigenetics as Art Student Worksheet and Epigenetics as Art Student Worksheet- Modified as needed.

Use the Epigenetics as Art Powerpoint to project on the board.

Using Slide 13 of the Epigenetics as Art Powerpoint, have students write down the definitions of content and form. Explain that in our brains the form, or structure, combines with content, or meaning, to create and interpret imagery. This combination of content and form contributes to how we understand and see art. Explain how the third image (from left to right) on Slide 13 was created by combining the content of the first image (buildings) with the artistic form (painting style) of the second image to create a unique artistic representation of buildings on a street.

Using Slide 14, have the students analyze both images to determine how both content and form are used to illustrate scientific concepts. Ask them the following questions:

- What forms are used in each artwork?
- What content is being conveyed to the viewer?

For at least five minutes, have the students create a visual representation of how their assigned experience during pregnancy affects fetal and child development.

The assigned experiences are:

- No Stress or Cannabis Use During Pregnancy
- Cannabis Use During Pregnancy
- Stress During Pregnancy
- Stress and Cannabis Use During Pregnancy

3. Extended Writing | 10min

Use Epigenetics as Art Student Worksheet and Epigenetics as Art Student Worksheet- Modified as needed.

Have students write a paragraph-length explanation for how their art piece represents how stress and cannabis use during pregnancy impacts gene expression.

Students should explain how certain colors, imagery, and elements represent changes in genetic expression, including children's behaviors as they grow and develop, by connecting their artwork to concepts from the previous class's Think, Ink, Link Protocol and this class's graph analysis. Students should include at least two pieces of textual evidence and analysis in order to support their artistic choices.

1. Reflection | 2min

Use Epigenetics as Art Student Worksheet and Epigenetics as Art Student Worksheet- Modified as needed.

Have students silently and independently answer the three reflection questions to briefly consider how art can be used as a metaphor or illustration of scientific concepts. Collect students' worksheets at the end of class.

Standards

CONTENT SPECIFIC CURRICULUM	Living Environment Core Curriculum • Performance Indicator 2.1a • Performance Indicator 4.1e • Performance Indicator 4.1h
NEXT GENERATION SCIENCE STANDARDS (NGSS)	Life Sciences ▪ HS-LS3-2 Hereditary: Inheritance and Variation of Traits Cross-cutting concepts ▪ HS-LS3-1 ▪ HS-LS3-3
COMMON CORE STANDARDS	• RST.11-12.1 • .RST.11-12.9 • WHST.9-12.1 • MP.2

Vocabulary

Placenta	A temporary organ that forms in the uterus during pregnancy. It attaches to the uterine wall and connects to the fetus through the umbilical cord. The placenta provides oxygen and nutrients to the fetus and removes waste products produced by the fetus.
Fetus	Offspring of a human or other mammal in the stages of prenatal development that follow the embryo stage (in humans taken as beginning eight weeks after conception).
Gene expression	The process by which information in a gene is turned into a function. Mostly occurs via translation of RNA molecules into proteins, which determine our physical traits and characteristics.
Epigenetics	The study of how your behaviors and the environment can lead to changes in gene expression. Unlike genetic changes, epigenetic changes do not change your gene sequence, but they can change how your body reads your gene sequence. Epigenetic changes are thought to be reversible.

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