

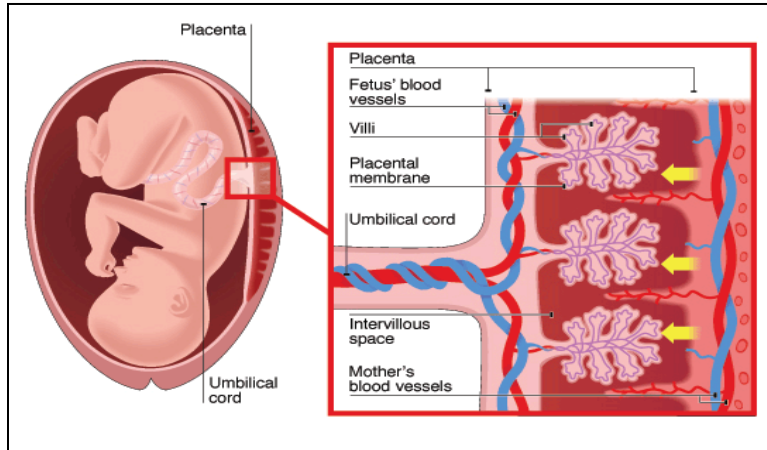
Name: _____

Date: _____

Learning Objective: Students will be able to explain how the structure and function of the placenta serves to protect and nourish a developing fetus by discussing and analyzing a text in a jigsaw activity.

Warm Up:

Observe the diagram below. Write 3 observations, 3 conclusions, and 3 questions you have about the diagram.



Exchange of Materials between Foetal and Maternal Blood. Image. BioNinja. Accessed March 11, 2024.
<https://old-ib.bioninja.com.au/higher-level/topic-11-animal-physiology/114-sexual-reproduction/placenta.html>.

See	Think	Wonder
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New Science Vocabulary Words:

Placenta	Definition:
Fetus	Definition:



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<p>4. Protection</p>	<p>How does the placenta provide immune protection to the developing fetus?</p> <p>Why is the immune protection provided by the placenta important for fetal development?</p> <p><i>Vocabulary: oxygen, diffusion, antibodies, gamma globulins, passive immunity, chickenpox, whooping cough</i></p>
<p>5. Neuro-development</p>	<p>How does the placenta affect neurodevelopment of the fetus?</p> <p>Why is it important to maintain homeostasis of neurotransmitter levels during pregnancy?</p> <p><i>Vocabulary: serotonin, dopamine, epinephrine, norepinephrine, oxytocin, cell death, cell creation, cell division, neuronal migration, synapses, hyperserotonemia, hyposerotonemia</i></p>

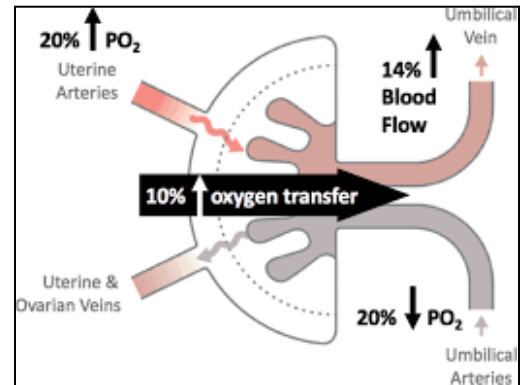


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Paragraph #1: Gas Exchange

During pregnancy, the supply of **oxygen** and removal of **carbon dioxide** gasses in the fetus depends on the placenta. Microscopic structures called **villi** form as part of the placenta. Each villus contains a network of blood vessels, and its outer surface is in contact with the mother's blood that flows through the placenta. As pregnancy progresses and the fetus grows, the tissue separating fetal and maternal blood becomes progressively thinner. The fetus needs oxygen to fuel **cellular**



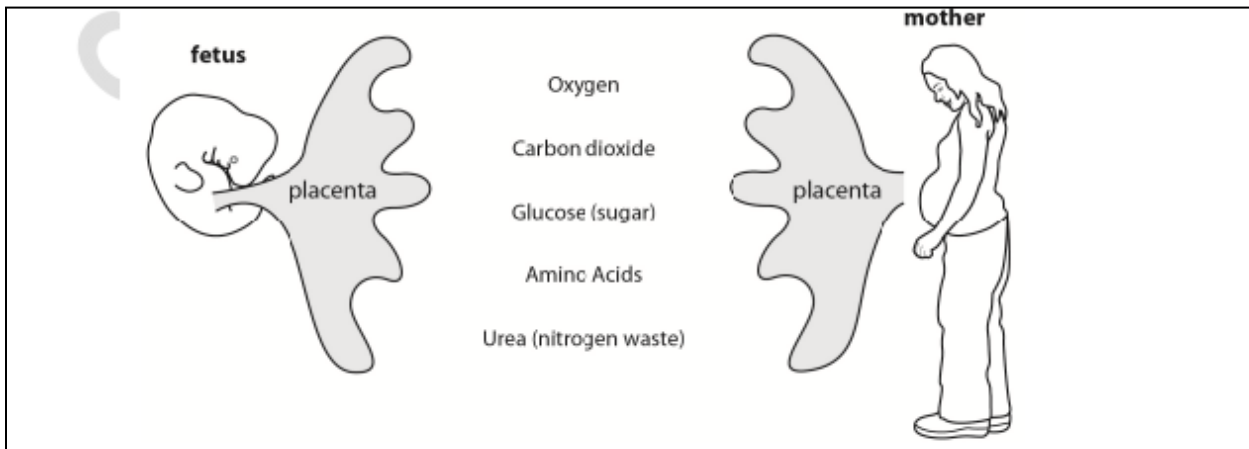
respiration and other processes in its cells. These reactions commonly produce **carbon dioxide** as a waste product that must be removed from the fetal blood. One of the main functions of the placenta is to allow **oxygen** in the mother's blood to **diffuse** into the fetal vessels and carbon dioxide in the fetal blood to diffuse into the mother's blood system. The placenta carries out this exchange of gasses as efficiently as the lungs do after birth. In late pregnancy, the placenta contains approximately 120 square feet of gas-exchanging tissue. Interruption of either fetal or maternal blood flow through the placenta can cause low oxygen levels in fetal tissues, which may endanger the fetus.

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Paragraph #2: Nutrients

When someone becomes pregnant, a flattened, disc-shaped structure called the placenta develops in the uterus. Made partly by the **uterus** and partly from fetal tissue, one side of the placenta connects to the **umbilical cord** while the other side attaches to the uterine wall. The placenta serves a critical role, supporting the growth and survival of the fetus throughout most of the 9 months of pregnancy. Although the fetal digestive system grows rapidly in the later stages of pregnancy to prepare the newborn infant for feeding, the placenta supplies the fetus with all its needed **nutrients** before birth. In the early stages of pregnancy, the placenta itself makes some nutrients, including **carbohydrates (sugars)** and **fats**, that move into the fetal blood and help nourish the fetus. As the fetus and placenta grow, the pregnant parent's blood **diffusing** through the placenta provides the fetus with the nutrition it needs. **Water** is essential for fetal growth and metabolism and diffuses freely across the placenta into the fetal **cardiovascular system**. **Protein building blocks** and **glucose (blood sugar)** also diffuse easily from the maternal blood through the placenta and into the fetal blood, providing the fetus with essential nutrients. **Vitamins** from the mother's circulation also pass through the placenta to the fetus.

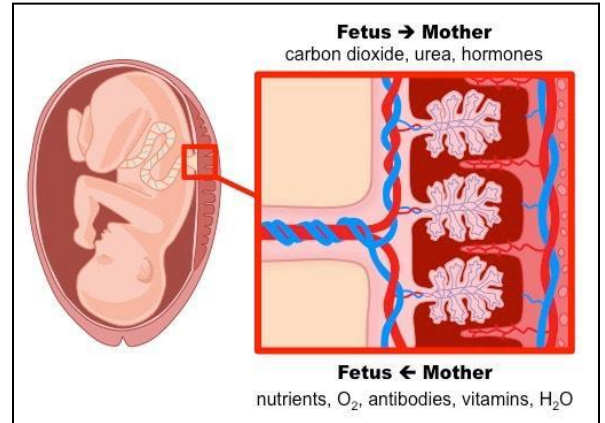


Name: _____

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Paragraph #3: Hormones

The placenta produces several important hormones, including **estrogen, progesterone, placental growth hormone** and **placental lactogen**. Although most hormones made by the placenta do not influence the fetus directly, they have an essential role in regulating the mother's responses to pregnancy. For example, progesterone from the placenta helps the lining of the **uterus** thicken and grow and stimulates **glands** in the lining to make nutrients used by the embryo during the early stages of pregnancy. Placental lactogen and growth hormone act primarily on the mother's body, stimulating it to provide increasing amounts of nutrients for the growing fetus. These hormones may also act on the fetus to directly promote growth, although this possibility needs to be confirmed with additional research.

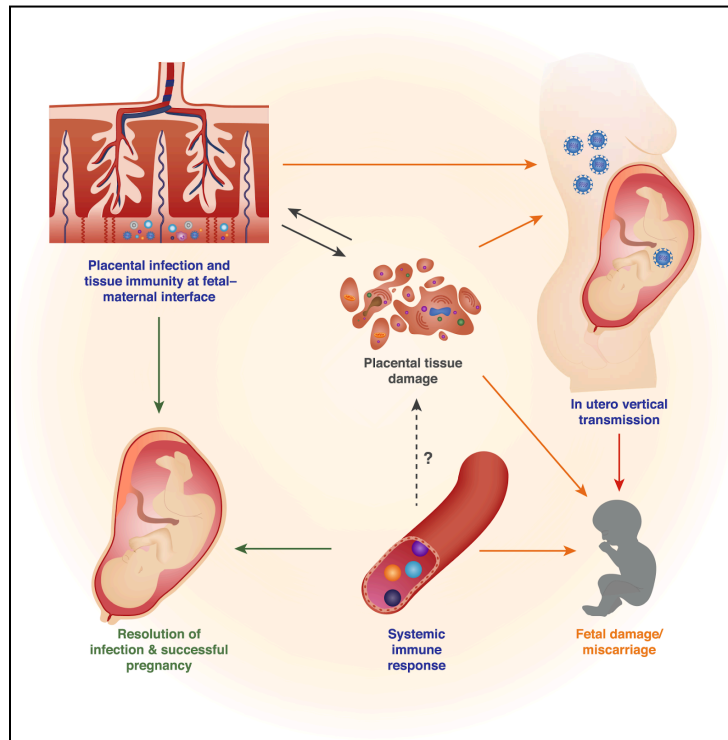


Name: _____

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Paragraph #4: Protection

In addition to providing the fetus with **oxygen** and **nutrients** by **diffusion**, the placenta helps protect the fetus from infections. It does this by transferring protective proteins called **antibodies** from the mother's blood to the fetal **cardiovascular system**. Certain types of antibodies, called **gamma globulins**, diffuse easily into the fetal blood. Other types of antibodies pass across the placenta in small quantities. This action by the placenta gives the fetus a type of immunity called passive, as it doesn't involve the activity of the fetal immune system. **Passive immunity** is an important protective mechanism because a fetus's immune system is underdeveloped. While passive immunity provides effective protection from some infectious diseases, the fetus is still susceptible to others, including **chickenpox** and **whooping cough**.



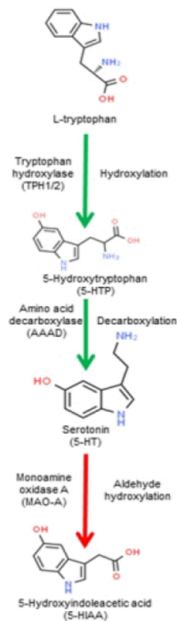
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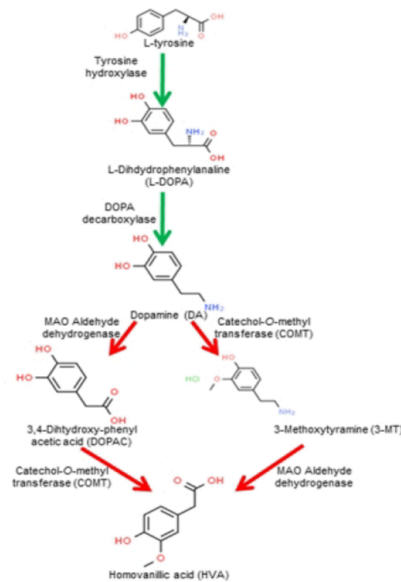
Paragraph #5: Neurodevelopment¹

Science research has long recognized that the placenta produces neurotransmitters. The placenta produces neurotransmitters, which regulates fetal brain development. The neurotransmitters the placenta creates are likely the sole source of neurotransmitters during initial brain formation, including **dopamine**, **epinephrine/norepinephrine**, and **serotonin**. Dopamine and epinephrine/norepinephrine regulate **cell death** and **cell creation** as well as signal to the body that someone is pregnant. During fetal brain development, serotonin stimulates **cell division**, **neuronal migration** (creation of central nervous system), **cell differentiation**, and the creation of **synapses** (connections between neurons). **Hyperserotonemia** (too much serotonin) at this time may cause a negative feedback loop that stops serotonin signaling by potentially preventing the expression of serotonin's receptors, including **oxytocin** production by the hypothalamus. Oxytocin promotes social behaviors. Hyposerotonemia (too little serotonin) may also be problematic as it can impair sensory, motor, and cognitive abilities.

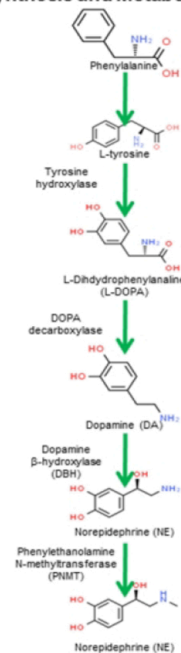
Serotonin (5-HT) Synthesis and Metabolism



Dopamine (DA) Synthesis and Metabolism



Norepinephrine (NE) and Epinephrine Synthesis and Metabolism



¹ Cheryl S. Rosenfeld, "The Placenta-Brain-Axis," *Journal of Neuroscience Research* 99, no. 1 (2020): <https://doi.org/10.1002/jnr.24603>.



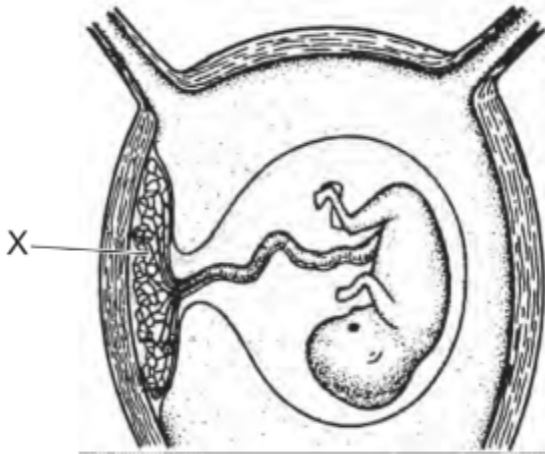
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Part II. Turn and Talk

1. Independently answer the Regents-based multiple choice question below and justify your answer using evidence from the text in the space provided.
2. Share your response with your partner and agree/disagree with their response using evidence from the text.

The diagram below represents a developing fetus in a human.



What would most likely happen if structure X were damaged in the early stages of pregnancy?

- A. The genes from the mother would not be turned on in the fetus.
- B. The nutrients necessary for development would not be able to reach the fetus.
- C. The fertilized egg would not be able to travel from the ovary to the uterus.
- D. Development would take longer since the fetus would have to synthesize nutrients.

Explain why your answer choice is correct in the space below.

Answer choice _____ is correct because...



Name: _____

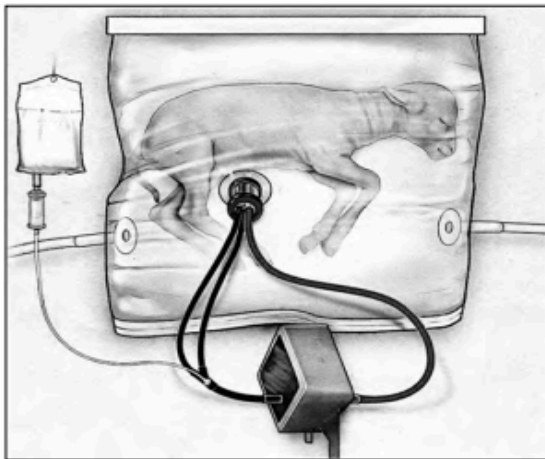
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Part III. Exit Ticket

- Independently complete the Regents-based short-response questions below using evidence from today’s lesson to support your answer.

Science Word Bank		
Placenta	Uterus	Cellular Diffusion
Oxygen	Carbon Dioxide	Cellular Respiration
Nutrients	Water	Metabolism
Cardiovascular System	Blood Vessels	Uterine Lining

Base your answers to questions 54 and 55 on the information below and on your knowledge of biology.



Source: Children's Hospital of Philadelphia/Discover Magazine, January/February 2018, Page 24

Biobag System

After decades of research, scientists have developed a biobag system with the potential to save extremely premature babies. They have successfully removed eight lamb fetuses from their mothers and placed them into biobags. Eventually, the fetuses developed into healthy sheep.

The biobag is a clear plastic bag filled with a solution of water containing various salts. A machine outside the bag is attached to the blood vessels in the lamb’s umbilical cord. The lamb’s umbilical cord brings in nutrients, and its heart pumps blood through an external oxygenator that removes carbon dioxide from the blood and adds oxygen.

The biobag models early development in the reproduction of mammals. In the future, this system may be able to be used with human premature babies. The biobag system could allow them to continue to develop for a longer period of time.

- Two parts of the biobag system are the plastic bag and the external oxygenator. Select *one* of these parts and circle it below. Identify the structure in the reproductive system that the part of the biobag system you selected represents, and state the function of that part. [1]

Circle one: Plastic bag External oxygenator

- State *one* reason why medical advances that might be helpful to people are tested first on organisms such as sheep. [1]



Name: _____

Date: _____

**Epigenetics as Art:
The Effects of Stress and Cannabis Use During Pregnancy on Children's Neurological
Development**

Learning Objective: Students will be able to explain the impact of stress on genetic expression and generational inheritance by creating a visual representation of the connection between lived experience and genetic expression with an accompanying explanatory writing response.

Warm-Up:

1. Describe the relationship between the pregnant parent, the placenta, and the fetus.

2. Explain the biological processes involved in the relationship between the pregnant parent, the placenta, and the fetus.

Science Vocabulary Words: Placenta, Fetus, Macronutrients, Micronutrients, Oxygen, Carbon Dioxide, Gas Exchange, Cellular Diffusion



Name: _____

Date: _____

New Science Vocabulary Words:

<p>Gene Expression:</p>	<p>Definition:</p>
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<p>Epigenetics:</p>	<p>Definition:</p>
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Name: _____

Date: _____

Part I. Background Information

1. Discuss and describe with your group how the following experiences during pregnancy affect neurodevelopment in children after birth in your own words while analyzing all of the graphs at your table:

No Stress or Cannabis Use During Pregnancy	Cannabis Use During Pregnancy	Stress During Pregnancy	Stress and Cannabis Use During Pregnancy
<p>How is this experience during pregnancy similar to or different from the other experiences mentioned?</p>	<p>How is this experience during pregnancy similar to or different from the other experiences mentioned?</p>	<p>How is this experience during pregnancy similar to or different from the other experiences mentioned?</p>	<p>How is this experience during pregnancy similar to or different from the other experiences mentioned?</p>
<p>What conclusions can you draw from your observations?</p>	<p>What conclusions can you draw from your observations?</p>	<p>What conclusions can you draw from your observations?</p>	<p>What conclusions can you draw from your observations?</p>



Name: _____ Date: _____

Part II. Visual Representation of Stress and Cannabis Use on Gene Expression

1. **Assigned Experience During Pregnancy:** _____

Brainstorming

What do I need to include in my artwork?

Form	Definition: In My Artwork:
Content	Definition: In My Artwork:

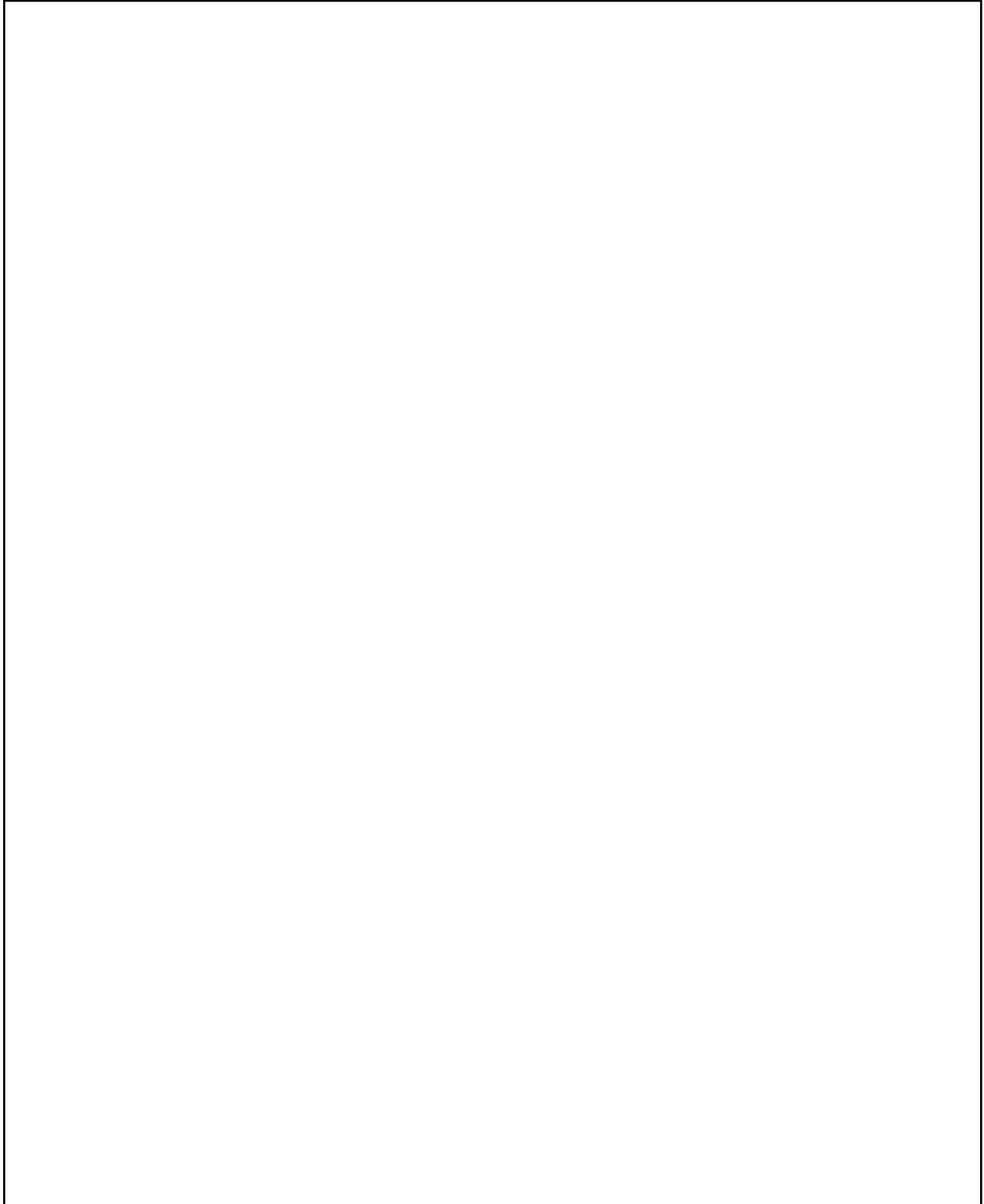
2. How might your assigned experience during pregnancy affect gene expression, including as the child grows and develops after birth?



Name: _____

Date: _____

Sketch a Draft



Name: _____

Date: _____

Part III. Extended Writing

Directions: Please write a paragraph-length explanation for how your art piece represents how stress and cannabis use during pregnancy impacts gene expression. Make sure to explain how certain **colors**, **imagery**, and **forms** represent changes in genetic expression, including children's behaviors as they grow and develop.

Science Word Bank		
Aggression	Stress	Gas Exchange
Anxiety	Cannabis	Cellular Diffusion
Hyperactivity	Placenta	Gene Expression
Cortisol	Fetus	Epigenetics

Outline

Claim → _____

Evidence #1 → _____

Analysis #1 → _____

Evidence #2 → _____

Analysis #2 → _____

Conclusion → _____



Name: _____

Date: _____

Part IV. Reflection

1. Did you like this activity? Why or why not?

2. How did it feel to represent a scientific idea in a creative way?

3. How could you use this process in other areas of school and studying?

