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Improving In Vitro Fertilization

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Nate Butler , Steve Gertz, Nicole Cannavino, and Christina Schaefer Lesson Plan

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Authentic question (Challenge Question):**How can we make IVF more successful?**

Grade Level: 10th Grade
Subjects: Biology and Mathematics (Co-teaching)
Lesson Duration: 80 min.
Topic: Factors affecting successful embryo implantation

Embryo Implantation Lesson Standards

NYS Living Environment Core Curriculum

Standard 1
Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

Key Idea 3:
The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into natural phenomena.

PERFORMANCE INDICATOR 3.1 Use various methods of representing and organizing observations (e.g., diagrams, tables, charts, graphs, equations, matrices) and insightfully interpret the organized data.

Major Understandings 3.1a Interpretation of data leads to development of additional hypotheses, the formulation of generalizations, or explanations of natural phenomena.

PERFORMANCE INDICATOR 3.2 Apply statistical analysis techniques when appropriate to test if chance alone explains the results.

PERFORMANCE INDICATOR 3.3 Assess correspondence between the predicted result contained in the hypothesis and actual result, and reach a conclusion as to whether the explanation on which the prediction was based is supported.

Standard 4
Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Key Idea 1:
Living things are both similar to and different from each other and from nonliving things.

PERFORMANCE INDICATOR 1.2 Describe and explain the structures and functions of the human body at different organizational levels (e.g., systems, tissues, cells, organelles).

Major Understandings 1.2b Humans are complex organisms. They require multiple systems for digestion, respiration, reproduction, circulation, excretion, movement, coordination, and immunity. The systems interact to perform the life functions.

Major Understanding 1.2c The components of the human body, from organ systems to cell organelles, interact to maintain a balanced internal environment. To successfully accomplish this, organisms possess a diversity of control mechanisms that detect deviations and make corrective actions.

Major Understanding 1.2g Each cell is covered by a membrane that performs a number of important functions for the cell. These include: separation from its outside environment, controlling which molecules enter and leave the cell, and recognition of chemical signals. The processes of diffusion and active transport are important in the movement of materials in and out of cells.

Major Understanding 1.2j Receptor molecules play an important role in the interactions between cells. Two primary agents of cellular communication are hormones and chemicals produced by nerve cells. If nerve or hormone signals are blocked, cellular communication is disrupted and the organism's stability is affected.

Key Idea 4:
The continuity of life is sustained through reproduction and development.

PERFORMANCE INDICATOR 4.1 Explain how organisms, including humans, reproduce their own kind.

Major Understanding 4.1e Human reproduction and development are influenced by factors such as gene expression, hormones, and the environment. The reproductive cycle in both males and females is regulated by hormones such as testosterone, estrogen, and progesterone.

Major Understanding 4.1f The structures and functions of the human female reproductive system, as in almost all other mammals, are designed to produce gametes in ovaries, allow for internal fertilization, support the internal development of the embryo and fetus in the uterus, and provide essential materials through the placenta, and nutrition through milk for the newborn.

Major Understanding 4.1h In humans, the embryonic development of essential organs occurs in early stages of pregnancy. The embryo may encounter risks from faults in its genes and from its mother's exposure to environmental factors such as inadequate diet, use of alcohol/drugs/tobacco, other toxins, or infections throughout her pregnancy.

Next Generation Science Standards

DISCIPLINARY CORE IDEAS

LS1.A: Structure and Function- a) Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1); b) All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.); c) Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)

LS1.B: Growth and Development of Organisms- In multicellular organisms, individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4)

Common Core Mathematics Standards: Statistics and Probability

USE PROBABILITY TO EVALUATE OUTCOMES OF DECISIONS

CCSS.Math.Content.HSS.MD.B.5- Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.

CCSS.Math.Content.HSS.MD.B.5.b- Evaluate and compare strategies on the basis of expected values. *For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.*

CCSS.Math.Content.HSS.MD.B.7- Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

CCSS.Math.Practice.MP4 Model with mathematics- Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

Content Objectives:

Students Will Be Able To:
Model in-vitro fertilization with the use of Agent Sheets.
Hypothesize the reasons underlying variation among embryos in the likelihood of their implantation
Compare different models of in-vitro fertilization
Explain vocabulary needed for lesson
Consider multiple answers to the authentic question
Calculate the probability of pregnancy using the binomial formula
Calculate the probability of pregnancy using the combined formula via the mathematics applet
Calculate the percentage difference between the binomial formula and the combined formula
Analyze the results of the mathematical models to draw conclusions on in-vitro fertilization

Vocabulary:

- Zygote
- Placenta
- Embryo
- Fetus
- Differentiate
- Blastocyst
- Integrins
- Uterus
- Gastrula
- Trophoblast
- Progesterone
- Estrogen
- Implantation Rate
- Embryo Transfer
- Independent Events
- Bernoulli Trial
- Binomial Formula
- Combined Formula
- Mathematical Model Applet

Learning Tasks:

Students will review...The embryo implantation probability model will be used to demonstrate that the probability of embryo-uterine adhesion is influenced by the number molecular factors in the uterus, such as Integrin, the molecule on which our model focuses.

Activity	Description
1. Biology and mathematics concepts review	Beginning of the lesson (BIO) Students will already have read an article based on in vitro fertilization, review what they already know, and then prepare questions and predictions for *reading with a question in mind*. Students will then read an article[1] on in vitro fertilization and engage in *support your position* scientific argumentation. (Math) Students have been previously introduced to Bernoulli Trials and the Binomial formula, yet have not had much practice applying these concepts.
2. Introduction to Models	The instructors will discuss with the students what models are used for Students will be shown the models that they will be using
3. Models and Observations	Students will be able to play with the model Students will observe what takes place in the model
4. Worksheet and/or Velcro tennis	Students will be given a Mathematics laboratory that allows students to run the AgentSheets model for a certain number of trials in order to determine the implantation rate of three different types of embryos. Then, students use these implantation rates to compute the probabilities of different types of pregnancies using both the binomial formula and the mathematical applet provided. During this process students will answer a series of mathematical and scientific questions. (40 mins) Students may be given a new worksheet in which they can use to record observations made from playing the "velcro tennis" game. The Velcro tennis game will be explained to students (**if used**) and any safety hazards should be stated before allowing students to play. Students will play "velcro tennis" for 10 trials. This will give students

[1] http://healthland.time.com/2013/05/30/frontiers-of-fertility/
[1]

	another means of practicing Binomial probabilities in a Science setting (**if used**).
5. Wrap-up of Concepts Covered	Teachers will answer any remaining questions that the students have Teachers will ask questions to solidify student learning of the authentic question asked Teachers will respond to any misconceptions still remaining Informal assessment and/or homework assignment should be given to students.

Informal Assessment Strategies

Lesson Strategy: *Reading with a Question in Mind*

Before interacting with information (e.g., text [spoken, written, visual], cultural artifact, manipulative), students generate questions around a specific topic using prior knowledge. The teacher will introduce a topic or title of an article and students record what they know about the topic or any questions they may have. The teacher then reads an interesting selection from the text and students respond. As a class or individually, students generate questions, comments, thoughts, or predictions. They then read the entire text with their questions and thoughts in mind while noticing and annotating any questions answered or new information.

Students then explain or elaborate on their responses in small-group followed by whole-class discussion. This helps to answer questions and evaluate understanding.

Reading with a Question in Mind is typically used before an assigned reading to help students pick out most important information while reading a difficult or lengthy text. It will help students to hone in on important and relevant information and prevent them from getting caught up in less relevant details (Daniels and Steineke, 2011, p38). It could also be used before watching a science related video, helping students to stay engaged. It is used to activate students' prior knowledge and generates curiosity. It also is a way for students to practice generating good effective questions.

edTPA Language Function: PREDICT (or forecast) and INFER, PROVIDE EVIDENCE

Materials Needed: Information (text [spoken, written, visual])

steps: How to use? (Daniels and Steineke pp 38-39)

1. Introduce the topic:

"Today we are going to read... What do you think this means? What do you think this scientist may have done? Turn and talk in pairs about your thoughts."

2. Share Ideas

Invite volunteers to share thoughts and ideas. Ask students to offer hypotheses, guesses, or answers and list or project them

3. Read Aloud

Now read the article, text, or video title and abstract or interesting selection found in the within text.

4. Students Respond

Let students react and comment. If it is appropriate, teacher offers their reaction**.**

5. Brainstorm

Now, invite students to offer their evidence as to why they think what they do. They can work in small groups or pairs, with someone serving as recorder. After some work time, regather and create a whole-class list of possible explanations.

6. Read with questions in mind.

Now hand out the article, text, or view video and have students read or watch with questions and/or predations in mind. Tell them to mark the text with A (for answered) when their question(s) are answered or prediction confirmed. They should also flag new, unpredicted reasons with an N (for New). Allow for reading and writing time.

7. Share and debrief.

Either in small groups or back in the whole class, have students share in two steps:

1. Which of your questions got answered or guesses confirmed?

2. What new information did you discover?

ADDITIONAL edTPA LANGUAGE FUNCTIONS addressed: DISCOURSE (and possibly vocabulary)

This strategy is a great way to promote a number of principles important to the NYS Core Curriculum Learning Standards.

Standard 1: Analysis, Inquiry, and Design

SCIENTIFIC INQUIRY:

· S1.4 Seek to clarify, to assess critically, and to reconcile with their own thinking the ideas presented by others, including peers, teachers, authors, and scientists.

· S1.2a independently formulate a hypothesis

· S1.1 Formulate questions independently with the aid of references appropriate for guiding the search for explanations of everyday observations.

When this strategy is used in a science classroom, students do inquiry-based learning by creating a prediction and formulating questions independently.

Used prior to reading scientific articles--specifically biological studies that are often difficult to read--this strategy increases engagement in reading texts as well as further improves students' skills in developing predictions based on prior knowledge. Reading with a question in mind is also a good way to assess students' thinking and determining any misconceptions.

Lesson Strategy: *Support Your Position*

This strategy is designed to guide students towards deeper levels of thinking. Students at in middle and high school are called upon to "cite textual evidence to support analysis of what the text says explicitly as well as inferences from the text" (Daniels and Steineke, 2011, p. 78). This rigorous approach is aligned with the Common Core Learning Standards that encourage students use stronger evidence to support claims. *Support Your Position* helps students strengthen their ability to use evidence discriminately. It also helps them recognize that arguments are judged on the basis of sound logic and evidence.

· Find an article

· Choose a topic to debate

· Create a thesis

· Search for evidence

· Use evidence to support position

This is a good strategy to use when a controversial topic is soon to be introduced. Students pick a side of the topic to argue for or against (they should be encouraged to find strong evidence to

support their position). This is a great way to help students build stronger arguments in class and in other areas of their lives. This can also illustrate that "many of the truths we cling to depend greatly on our own point of view" (Kenobi, 1983).

edTPA Language Function: ANALYZE, ARGUE, DISCOURSE, PROVIDE EVIDENCE

Materials Needed: text (article)

Steps: How to use? (Daniels and Steineke pp 78-81)

1. Select and copy an appropriate article for class. You need a text that allows for multiple interpretations or arguments as well as an abundance of both "right there" information and information that requires a closer analysis of the reading. It should also require students to combine prior knowledge with information they gained through analysis of the document. The article doesn't have to be long or obscure by any means.

2. Introduce the topic. Ask for volunteers on what they already know about the topic, and gauge their level of background knowledge.

3. Give instructions for reading the text. Instruct students to think about the main points or arguments the article if trying to make, and have them jot down three to four conclusions this text leads students to make. Circulate as students work on the article.

4. Let students know that they will shortly be working in pairs. Let them know they will pick an argument they think is most important and work to find two pieces of evidence to support this claim.

5. Model this process of thinking and evidence-gathering for students. Let the class respond, and explicitly show them how you found your position and gathered evidence for it.

6. Let pairs draw their conclusions about the article at this point. Let groups move on to the next step unless students need more support in finding an argument.

7. Pairs should now begin examining their positions and searching for evidence. Circulate, confer, and assist groups as they work.

8. Have two pairs join up and present their findings to each other. One group will argue for a position, the other will challenge their position.

9. Have the pairs switch roles. Each session should take around three minutes.

10. Have pairs share with the whole class. Ask for volunteers to share a certain position and show their evidence, and ask if other pairs had similar positions that could offer additional evidence. Record this list for the whole class to see.

Link to Current Theory and Practice:

This strategy allows students to:

· Think more deeply about their reading by requiring closer analysis of the reading.

· Use prior knowledge and background information to help understand their readings and their own arguments.

· Use stronger and more thorough evidence to support their claims.

The CCLS and NGSS require students to closely evaluate data, draw inferences from data, generalize from data, and identify and locate a wide variety of sources or evidence to support their claims about a certain topic. Making arguments that are supported by evidence is an integral part of the sciences, and this strategy is ideal for helping students build skills necessary to think like scientists.

This would be is a perfect strategy to use when students are learning concepts associated with politically-controversial topics, such as this lesson involving in vitro fertilization or others such as climate change and evolution. Students would create stronger arguments based on evidence, which could serve as valid replacements for mere opinions about the world around them.

Assessments:

Student learning will be informally assessed through their participation in lesson activities, responses to the *reading with a question in mind* and *support your position* strategies, and a 3-2-1 exit ticket. Formal assessments will be differentiated to include the options of a collage, diorama, or short essay based on a news article about invitro fertilization, to be due the following week.

Resources:

Brosens, J. J., Salker, M. S., Teklenburg, G., Nautiyal, J., Salter, S., Lucas, E. S., ... & Macklon, N. S. (2014). Uterine selection of human embryos at implantation. *Scientific reports*, *4*.

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http://www.nextgenscience.org/hsls1-molecules-organisms-structures-processes

http://healthland.time.com/2013/05/30/frontiers-of-fertility/

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