Secondary school biology teachers constantly face the challenge of finding ways to connect students with topics that are engaging and relevant to them. In-vitro fertilization and other assisted reproductive technologies are increasingly common medical practices that students may hear about in their lives outside of school, whether from hearing about a celebrity couple or knowing a family member that is seeking fertility treatment. This article presents a three-day case study of a young married couple facing infertility and explores the topic of human reproduction through case study and scientific argumentation.

Designed to act as an extension or practical application of a human reproduction unit in a high school biology class, students adopt the role of fertility specialists. Throughout the lesson, students integrate and apply their knowledge of human reproductive anatomy and physiology as they evaluate hormone levels, consider the role of negative feedback and cell receptors, and engage with various patient “test results,” or clues. By positioning students as doctors who are evaluating clues that a real-life fertility specialist might encounter, this case study empowers students to envision themselves as physicians. It contextualizes scientific knowledge that is taught in school and allows students to perceive how their education has valuable, real-world applications.

In this case study, a young couple, Jailyn and Carlos Jenkins, make an appointment with a fertility clinic. The couple have been unsuccessfully trying to start a family. After communicating this information, teachers can inform students that it will be their job to act as Jailyn and Carlos’s fertility doctor. Teachers can emphasize that the information students will evaluate throughout this case study is the same information that a real-life fertility specialist would assess. As students use clues to study the couple’s medical history and various test results, they brainstorm the situation variables, answer questions on potential causes of infertility, and eventually propose reasons and treatments for the couple’s infertility.

This case study is appropriate for Grades 9–12 and aligns with the Next Generation Science Standards (see Online Connections), which supports disciplinary core ideas for how specialized cells within organisms help them perform essential life functions (reproduction) and how feedback mechanisms play an essential role in regulating those functions. Additionally, it focuses on exemplary science practices such as engaging in argument from evidence.

Case studies and argumentation
A case study is a description and analysis of a particular situation where students become intellectually and socially engaged in effective learning through scientific inquiry and problem solving. Case studies are therefore an excellent means to involve students in topics as extensions of active learning to supplement core ideas and topics being studied. Similarly, according to Llewellyn (2013), scientific argumentation is a “critical-thinking skill that helps students propose, support, critique, refine,
justifying, and defend their positions on an issue” (p. 19). Looking at Figure 1, one can see how effectively case studies complement scientific argumentation in today’s science classrooms.

In addition, throughout the Case Study–Argumentation Cycle, students learn lifelong skills and habits of mind that are beneficial beyond the science classroom. They include

- formulating claims based on evidence,
- constructing an argument,
- voicing their privately held conceptions,
- forming decisions to justify a position taken,
- improving their abilities to frame an argument,
- having evidence-based discussions,
- debriefing and reflecting on another’s point of view,
- providing counterclaims to another’s position,
- becoming more proficient in argumentation, and
- improving their speaking and listening skills (Llewellyn 2013, p. 22).

Background on reproduction and fertility
Prior to introducing this case, students need to know how the anatomy, hormones, and physiological reactions of the female reproductive system interact to ensure a healthy pregnancy. Students should further understand that the ovaries are the organ in which the oocytes are matured. During ovulation (typically on Day 14 of a woman’s menstrual cycle), an egg travels from the ovary to the fallopian tube. In the fallopian tube, the egg may become fertilized if sperm are present. A fertilized egg is called a zygote. The zygote undergoes a process called mitosis and develops into an embryo, which travels into and implants in the wall of the uterus. Here, the embryo undergoes specialization and develops into a fetus. As a prerequisite, students should have basic knowledge of genetic disorders and be familiar with the process of gel electrophoresis.

Context for case study
This case study is intended to be a practical application of students’ knowledge in which they demonstrate understanding of how and why hormones influence the events that take place in the female and male reproductive systems. Students will construct an argument for the cause of the couple’s infertility and use evidence to defend their claims. Additionally, students will explore how outside influencers, such as drugs, BPA (an endocrine disruptor found in some plastics), and anabolic steroids, can harm an organism’s ability to maintain homeostasis and reproductive potential.
As students work their way through the case study, they record their progress in a packet that guides them through the clues. This case is designed with the intention of allowing students to choose how to investigate the case study as they work through the clues independently or in small groups of two or three. This case is also designed to give students varied ways to demonstrate their understanding of human reproduction. Evidence of understanding can come from student-to-student discussions, whole-class summary discussions at the end of each day, students’ write-ups in their packets, students’ diagnoses, and students’ presentations of their diagnoses.

Essential to this case study is the students’ use of inquiry and argumentation. There is not one “right” answer to the couple’s infertility. Students must act as doctors/scientists, obtaining information from the clues and using their knowledge to interpret the clues and come to a diagnosis, just as a real doctor would. Students could potentially argue for the cause of infertility being the female partner’s abnormal growths in her uterus, the presence of a gene associated with infertility, or the male partner’s abnormal hormone levels. Potentially acceptable student responses are included with the case study lesson materials, but this is not an exhaustive list. Students could conceivably argue for a different cause of the couple’s infertility. Overall, the emphasis is on students’ use of evidence in supporting their claims to make a scientific argument.

**Preparation**

All of the materials needed for this lesson are available online. Materials include:

- Case Study Packet
- Clues #1–6
- Teacher’s Copy of the Case Study Packet with potential student answers

The teacher should print enough copies of the Case Study Packet for the class. The packets are designed to be filled out by an individual student, but one packet could also be shared among a small group of two or three students. The packet is designed to be completed in three days, approximately corresponding to three 45-minute class sessions. On the first day, students start on the front page of the Case Study Packet and answer questions that guide them through the case study and clues. The packet and clues are intended to be helpful scaffolding for students so that the teacher is available to circulate among students as they work, facilitating their progress by asking guiding questions, or motivating students to provide supportive evidence for their claims.

The teacher should also print the six clues ahead of time. Teachers can make several copies of each clue so that multiple students can inspect the same clue simultaneously. The teacher

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**FIGURE 1**

Case study and argumentation cycle.
should then place the copies of each clue in its own folder and set the folders in a location within the classroom that is accessible to all students. As students work at their own pace through the Case Study Packet, the packet will periodically prompt them to retrieve the next clue. The implementation of this three-day unit in a biology class is outlined next to provide the reader with an idea of how students would engage with the material.

**Day 1**

Day 1 begins with the teacher setting the scene. Students are designated as doctors who specialize in fertility. In their roles, students diagnose and treat causes of infertility and other problems related to human reproduction. One day, a couple named Carlos and Jailyn Jenkins visit the fertility clinic. The couple have been trying in vain to start a family, and they are seeking your students’ medical help. Students are instructed to act like doctors by evaluating the evidence to render their official diagnosis for the cause of the patients’ infertility. The teacher emphasizes to the students that the answers they write are important, but equally important is their reasoning for why they wrote them. Students are instructed to evaluate the clues carefully because, like real doctors, they must evaluate and separate the important factors from irrelevant ones.

Before receiving their first clue, students complete an anatomy review page in the Case Study Packet. They identify key structures of the male and female reproductive systems on scientific diagrams. They also use these diagrams to illustrate four events that must occur to produce a viable pregnancy. Students could identify events such as: ovulation of an egg from the ovary into the fallopian tube, fertilization, mitosis to create an embryo, and specialization/differentiation of the cells to form a fetus. The teacher may instruct the students to work through the first page on their own, or he/she may guide the whole class in completing the first page (or part of it) together. Once the first page is complete, the packet instructs students to retrieve Clue #1.

Clue #1 contains the medical histories of Carlos and Jailyn Jenkins. Students read information on the medical histories and decide if there is any indication about what the cause of infertility may be. Here, students must use their critical-thinking skills and identify potentially relevant information and disregard irrelevant information. Like in real life, the cause of infertility is not immediately obvious to the student physicians evaluating the patients’ medical histories. Potential student answers from Clue #1 are included in the teacher’s copy of the Case Study Packet.

Next, in their role as fertility specialists, students chose to test the female partner’s hormone levels. After answering review questions about estrogen and progesterone, students retrieve Clue #2, Jailyn’s hormone levels. Students compare Jailyn’s hormone levels to physiologically normal hormone levels and use evidence from the clues and their packets to determine if Jailyn’s hormones may be the cause of her infertility. Again, potential student responses to Jailyn’s hormone evaluation are included in the teacher’s copy of the Case Study Packet.
The final clue for Day 1 is Clue #3, Jailyn’s pelvic ultrasound results. Students learn that the ultrasound shows that Jailyn has endometriosis, causing abnormal tissue buildup in and around her uterus. Again, they use evidence from the clues and their packets to determine if these abnormal tissues are the primary cause of the couple’s infertility. Students may determine that the abnormal tissue blocking Jailyn’s fallopian tube may be preventing ovulation or fertilization. Alternatively, they may decide that the tissue buildup is not affecting both sides of the uterus and therefore fertilization could potentially still occur. Again, the emphasis is on the students’ reasoning based on evidence for whatever conclusion they reach. Ten minutes before the end of each class, the teacher facilitates a whole-class discussion about the day’s discoveries and students’ current hypotheses. These discussions are important as it allows the teacher to evaluate student progress and understanding, and it gives students the chance to consider their classmates’ ideas in addition to their own.

Day 2
Day 2 begins with students taking a deeper look at Carlos as the primary person responsible for the couple’s infertility. Clue #4 gives students background information on anabolic steroids, which Carlos has admitted to taking. Clue #5 shows Carlos has had exposure to environmental toxins, like the hormone-disrupting chemical, bisphenol A (BPA), which is used as the context for introducing cell receptors and feedback loops. Similar to the instructions provided on Day 1, the teacher emphasizes that there is no one “right” answer. As students evaluate the evidence, they are encouraged to take their time to make a diagnosis emphasizing the supportive evidence and reasoning.

FIGURE 2

Student poster explaining and defending final diagnosis.
for the students’ claims. Potential student answers are included in the teacher’s copy of the Case Study Packet.

The final clue, Clue #6, offers background information on recent research in the field of genetic infertility. Students analyze gel electrophoresis results to find a possible link between Jailyn and other patients diagnosed with infertility. Again, the clues do not reveal one simple answer for the cause of the couple’s infertility. As the students continue to examine the case, they will constantly revise their hypotheses as they gather more empirical evidence and data.

Day 3
On Day 3, student groups create a poster explaining and defending their final diagnosis of the couple’s infertility (see Figure 2). On the poster, students pose the question being investigated, state their group’s claim for the cause of the infertility, list the evidence that supports their claim, and explain their reasoning for how the evidence supports their claim. Many students may suggest more than one factor contributing to the patients’ infertility. This is reasonable, since the case study is designed to support a variety of conclusions based on how students interpret the clues and evidence. However, students have to think like real doctors to evaluate multiple varied sets of data (or clues) and determine the most effective course of treatment for their patients.

After students present their posters to their peers, classmates are invited to pose questions and rebuttals to the presenters’ conclusions. This element of the lesson design encourages students to engage in collaboration with their peers, communicate their thinking, and think critically about their own conclusions.

Assessment rubric and survey
Any effective assessment tool, whether it is a traditional assessment or an alternative one, should specify the knowledge, skills, and understandings the student is expected to master at the conclusion of the unit. In this example, the assessment for this case study involves a CER (claim-evidence-reasoning) rubric to assess the student’s ability to support his or her claim with quality evidence (see Online Connections).

A CER rubric shows students what high-standard work looks like and distinguishes between proficiency from exemplar to below standard performance. Note that the rubric should be distributed and discussed by the teacher before the argumentation portion of the case begins. This way, the students know beforehand what is expected at each level of performance.

Conclusion
How many times do teachers get asked the question, “Why do we need to learn this?” This case study is intended to provide students with an authentic experience using their scientific knowledge in a real-life context. In this activity, students engage with complex biological concepts and vocabulary terms in a meaningful way, making the material authentic, accessible, and relevant. Through this unit, students engage not only with the content but also the scientific practices used by practitioners. Self-Evaluation Form student comments included:

“I loved this activity because not only were we allowed to work at our own pace, but we were also allowed to partner up with some friends and help each other out. The independence that was granted during this activity let us as student[s] think and learn on our own with only a little guidance from our teacher.”

“That was super fun and engaging. Trying to piece together all the pieces to why the couple was infertile was challenging. I was really proud of my final decision on the couple’s infertility. I’m so happy I decided to do some Google searching during the case study or else I wouldn’t have ever latched onto that decision I made. The debate was a little scary but I’ve always been nervous talking to a big group of people but it was still really fun. ”

“After doing it, I felt like I could be a doctor and it could even be fun. It is like doing a puzzle. You have to mix and match and sort the information you have to get to the bottom of it.”

Online Connections
Teacher copy of case study packet: https://bit.ly/3zDoTal
Clue 1: https://bit.ly/3zAxgkL
Clue 3: https://bit.ly/3DhMsZ
Clue 4: https://bit.ly/2WAVZtn
Clue 5: https://bit.ly/3gPKizW

Additional Resources
During this unit students used Chapter 34 of the high school biology textbook, Biology – New York edition, by Miller and Levine (2010) as a print reference to completing the case. Other online creditable medical resources included:

- https://www.mayoclinic.org/diseases-conditions/infertility/symptoms-causes/sym-20354317
- https://www.cdc.gov/reproductivehealth/infertility/index.htm
- https://www.uclahealth.org/obgyn/infertility

References

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