Should the Olympics be Divided into Men's and Women's Events?

Submitted by: Beth Adler, Biology
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Target Grade: 9-12 Biology

Time Required: 90 minutes

Standards:

NGSS HS LS3-2 Inheritance and Variations of Traits

> Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

Lesson Objectives:

> Students will:
>
> - explain the causes of inheritable biological sex traits
> - make and defend a claim regarding the use of sex-verification techniques in the Olympics

Central Focus:

> Using the highly publicized case of Olympic athlete, Dutee Chand, students will make a claim regarding the use of sex-verification techniques in the Olympics, explore the inheritance of biological sex traits, and then use their exploration to modify and justify their claim. NOTE: This activity is recommended as a **summary exercise** for a 9th-12th biology unit on heredity. Students should be familiar with meiosis, nondisjunction, translocation, and mutations.

Background Information:

Before the lesson, it is important to address with students the need for respect surrounding issues of biological sex development and gender identity. Using offensive and inappropriate language will not be tolerated. Terms like gonads, testes, and ovaries are used scientifically in the lesson. Students need to be reminded to employ these terms scientifically. Students should understand that this lesson deals only with fetal development of sex characteristics. The lesson does not cover topics covered in health class. Despite initial discomfort, all levels of students are capable of approaching this topic maturely and conscientiously.

Materials

- presentation slides
- Google forms or Mentimeter (to poll student opinions)
- student worksheets
- student device/tablet with access to internet
- jigsaw articles (found on Presentation Slide #18)
- image cards A-H (found on Presentation Slide 21-28)
- computer, projector, and online access

Instruction

Engage (15 minutes)

- Teacher will present the objectives.
    - Objectives: Students will (1) explain the causes of inheritable biological sex traits and (2) make and defend a claim regarding the use of sex-verification techniques in the Olympics.
- Teacher will pass out student worksheet packets and will go over presentation slides 1-7 with class.
- Following along on pg. 1 of the student worksheet, students will respond to opening questions as an online poll using google forms or Mentimeter.
- Teacher will gather, tally, and share anonymously student responses.
- Students will write their reasoning for their answer choice on pg. 1 of the worksheet.

Explore: Complexity of Biological Sex Differentiation (15 minutes)

- Teacher will go over presentation slides 8-9 and provide directions for students.
- Students will use the links on slide 8 and their tablets to research the complexities of biological sex differentiation and complete the flow chart of fetal development of biological sex on pg. 2 of the student worksheet.
- Teacher will circulate room asking students to explain their choices.
- Teacher and class will go over the answers on slide 10.

Explain: Genetic Variations of Biological Sex Development (20 minutes)

- Teacher will go over slide 11 and pass out Jigsaw Articles to groups of 4 assigning each group member a different article.
- Students will read and annotate their assigned article. Students will note/highlight the karyotype, gene/chromosomes affected, and the genetic process associated with the variation. Students will complete pg. 3 of their worksheet by circling two images that visually represents the concept of the article.
- Teacher will monitor students reading and annotations, checking that students circle images on pg. 3.
- Students will present a summary of their article to the other group members.

Elaborate (20 minutes)

- Teacher will go over pg. 4 of student worksheet and slides 12-13, providing directions for students.
- Students will work together to improve the readings by providing a justification for each. Students will pick two images per article from pg. 3 of student worksheet. Then, students will write a justification for why they circled the image on pg. 3.

Conclude (20 minutes)

- Teacher and students will return to the question: “Should the Olympics be divided into Men’s and Women’s Events?” (found on slide 15)
- Students will review their initial answer to the question from pg. 1 of the worksheet. Then, students will use what they have learned about genetics of biological sex development to expand/modify/qualify their initial answer. Students will write this on pg. 5 of the worksheet and must cite at least three pieces of biological evidence and three genetic process vocabulary terms from this lesson to support their claim.
- Teacher will leave students with extension questions found on slide 17.

Differentiation

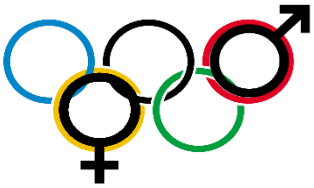
- Assign page one of student worksheet as homework the night before. Highlight and define vocabulary for ELL students.
- Pair struggling students with elbow partners.
- During Jigsaw activity, provide ELL with shortened and highlighted articles.
- Group students heterogeneously.

Assessment

1. Formative assessment during engage activity: teacher evaluates the initial views students have.
2. Formative assessment during explain activity: teacher monitors student progress of reading and annotating articles as well as the answer choices.
3. Formative assessment of flow chart during explore activity: teacher evaluates students' justification of answers.
4. Formative assessment of chart during elaborate activity: teacher evaluates students' justifications.
5. Summative assessment of student completed packets: teacher grades packets using a rubric and evaluates if students have met the objective of the lesson.

Teacher Background:

- World Health Organization - Gender and Genetics: http://www.who.int/genomics/gender/en/index1.html
- Interactives on Human Sex Development from the Hospital for Sick Kids http://www.aboutkidshealth.ca/En/HowTheBodyWorks/SexDevelopmentAnOverview/SexualDifferentiation/Pages/default.aspx
- Designing a NGSS Lesson http://ngss.nsta.org/designing-units-and-lessons.aspx
- Research on Female Athletes and Hyperandrogenism https://academic.oup.com/jcem/article/99/11/4328/2836760
- Genetic influence on athletic performance https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3993978/
- National Geographic Article on the Gender Spectrum https://www.nationalgeographic.com/magazine/2017/01/how-science-helps-us-understand-gender-identity/
- Genes and Athletic Performance National Institute of Health: https://ghr.nlm.nih.gov/primer/traits/athleticperformance
- The Elite Athlete Gene - ACTN3 https://ghr.nlm.nih.gov/gene/ACTN3#resources
- What qualifies a woman to be a woman? NYT - https://www.nytimes.com/2017/08/04/sports/olympics/gender-dutee-chand-india.html
- Fighting for the Body She was Born With - https://www.nytimes.com/2014/10/07/sports/sprinter-dutee-chand-fights-ban-over-her-testosterone-level.html?_r=0
- IAAF publications https://www.iaaf.org/about-iaaf/documents/medical
- The testosterone rule - constructing fairness in professional sport https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5570685



When is a Woman not a Man?

Name_____

ENGAGE: Silent Written Response- Should the Olympics be divided into Men's and Women's events? _____(yes or no)

Explain your reasoning:

HISTORY: Olympic Officials have a long history of defining and redefining requirements for athletes competing as women in the Olympics. Dutee Chand is the latest in a line of women athletes who have been banned from competing because they are "too masculine."

Timeline of Sex Verification in Sports

1900

Despite concerns athletics would be too stressful and/or cause masculinization, women were allowed to participate in the Olympics.

1960's

Worried Soviets would disguise men in order to compete in women's sports, the IOC instituted "Sex Verification Tests" – including visual inspection and XX chromosome testing.

1988

Maria Patino, Spanish Olympic Hurdler, banned from competing due to XY karyotype.

2009-2011

Caster Semanya dominates women's track and field World Championships. IAAF employs the "Testosterone Rule" requiring female athletes to have androgen levels less than 10nMol/L. Athletes with high levels were required to undergo surgery and hormone treatment before being allowed to compete.

2015-Now

IAAF suspends testosterone rule in response to Dutee Chand's legal challenge.

ESSENTIAL QUESTION: Can we determine who is a "woman" and who is a "man" using our knowledge of biological sex development?

EXPLORE the following interactives to learn about fetal development of biological sex. Fill in the flow chart as you work through the interactives.

Sexual Differentiation

http://www.aboutkidshealth.ca/En/HowTheBodyWorks/SexDevelopmentAnOverview/SexualDifferentiation/Pages/default.aspx

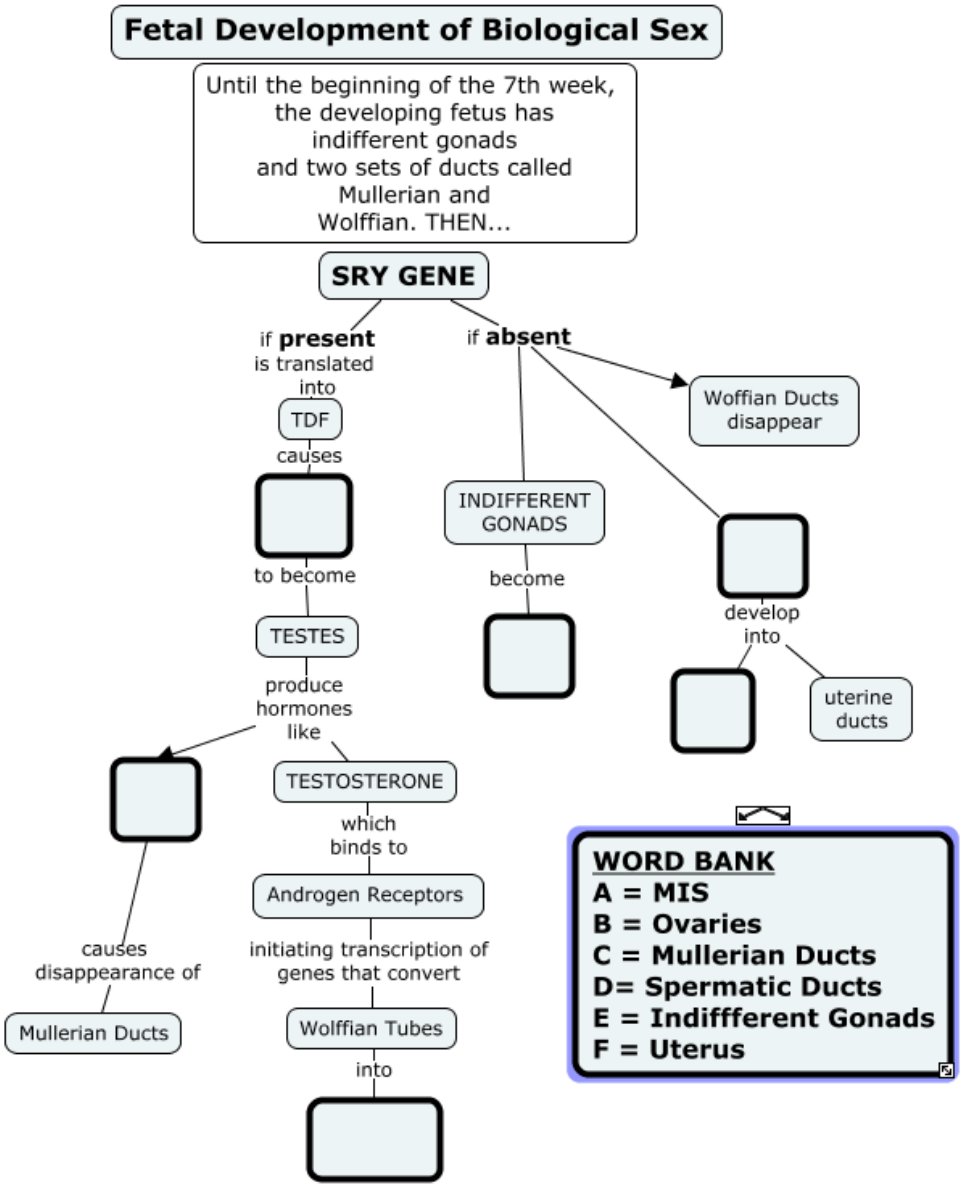
Chromosomal Sex
Gonadal Sex
Duct Differentiation

AIS/5ARD How Androgens Work

http://www.aboutkidshealth.ca/En/HowTheBodyWorks/SexDevelopmentAnOverview/AISand5ARD/Pages/HowAndrogensWork.aspx

Want to go further?

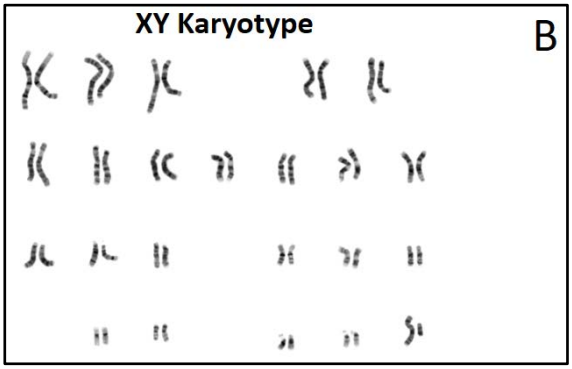
- The Androgen Receptor
- 5-Alpha-Reductase and DHT



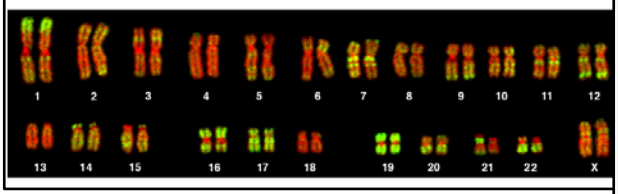
Explain – You will be assigned a short reading on one of the many genetic variations of biological sex development. Read very closely so that you can present a summary of the article to your group mates. Be sure to note/highlight the **karyotype, gene/chromosome affected,** and the **genetic process** associated with this variation. At least two of the images below would be appropriate to illustrate your article. Circle them.

X0 Karyotype A

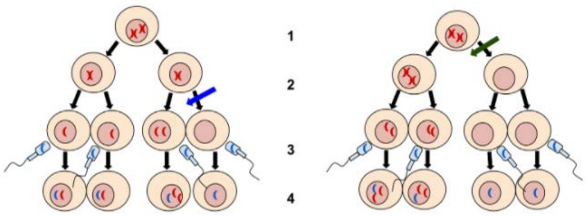
XY Karyotype B



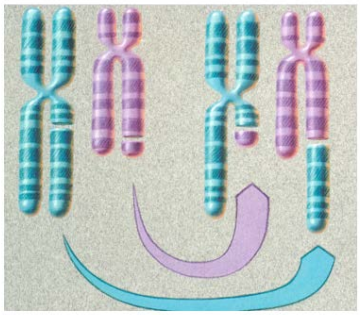
XX Karyotype C



Nondisjunction D



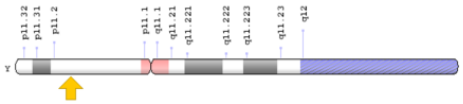
Translocation E



Typical Location of SRY Gene F

Cytogenetic Location: Yp11.2, which is the short (p) arm of the Y chromosome at position 11.2

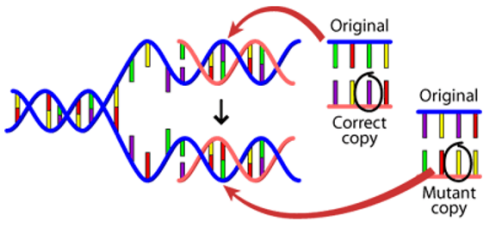
Molecular Location: base pairs 2,786,855 to 2,787,741 on the Y chromosome (Homo sapiens Annotation Release 108, GRCh38.p7) (NCBI)



Credit: Genome Decoration Page/NCBI

https://ghr.nlm.nih.gov/gene/SRY#location

DNA Replication Mistake G



https://evolution.berkeley.edu/evolibrary/article/0_0_0/evo_20 (Accessed 1/17/2018) Image Credit:University of California Museum of Paleontology (UCMP)

X-Linked Inheritance of AR Gene H

	X^{AR}	Y
X^{AR}	$X^{AR}X^{AR}$	$X^{AR}Y$
X^{ar}	$X^{AR}X^{ar}$	$X^{ar}Y$

ELABORATE : After all members of your group have presented their article summaries, you will work together to **improve** the readings by choosing at least **two relevant images per article** from the images on page 3. Write a **justification** for selecting the image in the appropriate box in the chart. If a row already has a justification, but you want to use the image again, you can place a check mark instead of writing another justification. You will finish with one justification per row. (See row B.) Place an **X** in the boxes for irrelevant images. Each image must be used at least once.

	Turner Syndrome	**Swyer Syndrome**	**46, XX testicular development**	**Androgen Insensitivity Syndrome**
A X0 Karyotype				
B Xy Karyotype		**Justification:** Individuals exhibit typical male karyotype but atypical sex characteristics.		✓
C XX Karyotype				
D Non-dis-junction				
E Trans-location				
F Location of SRY Gene	X			
G DNA Replication Mistake				
H X-linked inheritance of AR gene				

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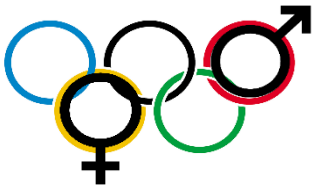

The high androgen level produced by my body is natural. I have not doped or cheated. If I follow the IAAF guidelines you have attached, I will have to undergo medical intervention in order to reduce my naturally produced androgen levels. […] I feel perfectly healthy and I have no health complaints, so I do not want to undergo these procedures […] I also understand that these interventions will most likely decrease my performance level because of the serious side effects and because they will interfere with the way my body has worked my whole life.[21] - **Dutee Chand** (Accessed 1/23/2018 from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5570685/)

<u>CONCLUDE:</u> Revisit your response and explanation to the question "Should the Olympics be divided into Men's and Women's events?" Now use your knowledge of the genetics behind biological sex development to expand/modify/qualify your response. Cite at least three pieces of biological evidence and three genetic process vocabulary terms from this lesson to support your claim.

When is a Woman not a Man? KEY

Name_____

ENGAGE: Silent Written Response- Should the Olympics be divided into Men's and Women's events? _____*(yes or no)*

Explain your reasoning:

Student Opinion

HISTORY: Olympic Officials have a long history of defining and redefining requirements for athletes competing as women in the Olympics. Dutee Chand is the latest in a line of women athletes who have been banned from competing because they are "too masculine."

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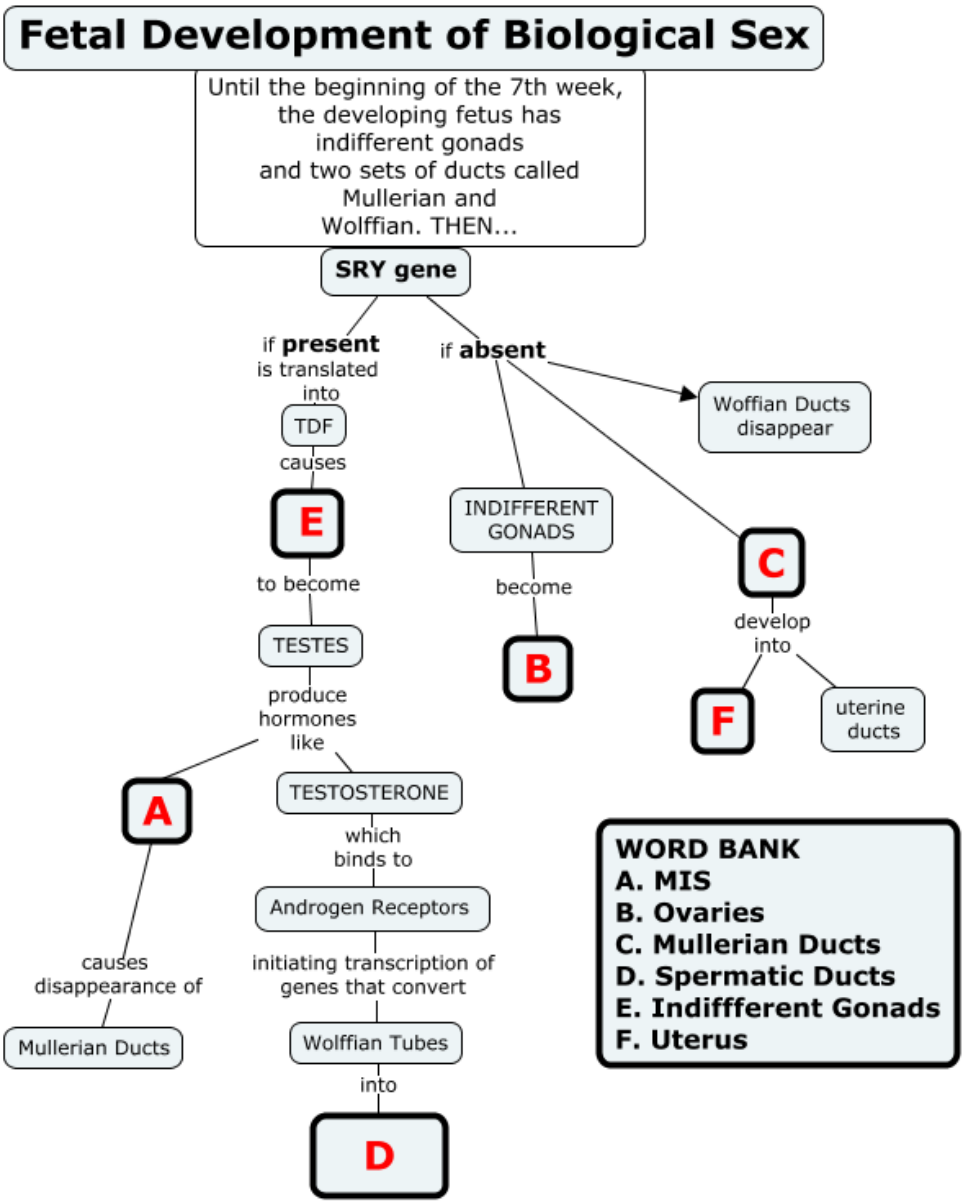
- Chromosomal Sex
- Duct Differentiation
- Gonadal Sex

AIS/5ARD How Androgens Work

http://www.aboutkidshealth.ca/En/HowTheBodyWorks/SexDevelopmentAnOverview/AISand5ARD/Pages/HowAndrogensWork.aspx

Want to go deeper?

- The Androgen Receptor:
- 5-Alpha-Reductase and DHT



EXPLAIN and ELABORATE : You will be assigned a short reading by your teacher about one of the many genetic variations on typical biological sex development. After presenting your articles, your group will work together to **improve** each article by selecting relevant images that help explain the article. Place an **X** in the boxes for images you would not use for that particular article. Write a justification in the correct box for images you would use. Justifications need only be written once. Indicate repeated justifications with a check mark instead of an X. *Student responses may vary. Stress the importance of justification.*

	Turner Syndrome	**Swyer Syndrome**	**46, XX testicular development**	**Androgen Insensitivity Syndrome**
A X0 Karyotype	Individuals have only one sex chromosome. They exhibit a 45 "X0" karyotype.	X	X	X
B Xy Karyotype	X	Individuals exhibit typical male karyotype but atypical sex characteristics.	X	✓
C XX Karyotype	X	X	Individuals exhibit typical female karyotype, but some male characteristics.	X
D Non-dis-junction	Shows what happens when homologous chromosomes fail to segregate and separate during meiosis.	X	X	X
E Trans-location	X	X	SRY gene, typically located on the Y, has been translocated onto the X chromosome.	X
F Location of SRY Gene	X	Shows location of the SRY gene. In this case, the gene has mutations.	Shows typical location of SRY gene before translocation or **X**	✓ or X
G DNA Replication Mistake	X	Shows how mistakes (mutations) in DNA replication can lead to gene malfunction.	X	✓
H X-linked inheritance of AR gene	X	X	X	Xy Individuals carry only one copy of mutated AR gene thus exhibiting female characteristics.

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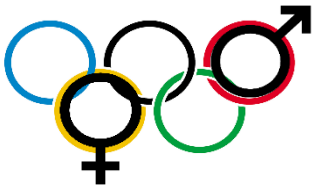

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GRADING RUBRIC	Emerging	Proficient	Mastery
Evidence	Claim is unstated. Students justify claim using 0-1 pieces of evidence from this lesson.	Claim is stated. Students justify claim using two pieces of evidence from this lesson.	Claim is clearly stated. Students justify claim using three pieces of evidence from this lesson.
Understanding	Students employ vocabulary from three genetic process discussed in this lesson correctly 1/3 or no times.	Students employ vocabulary from three genetic process discussed in this lesson correctly 2/3 times.	Students employ vocabulary from three genetic processes in this lesson correctly.
Expression	Discussion is unorganized, and difficult to understand.	Discussion is somewhat organized, mostly grammatically correct, and fairly easy to understand	Discussion is clearly organized, grammatically correct, and easy to understand.