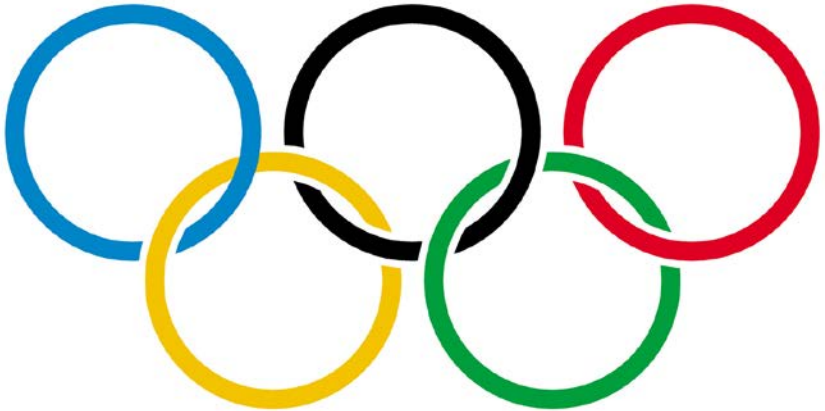
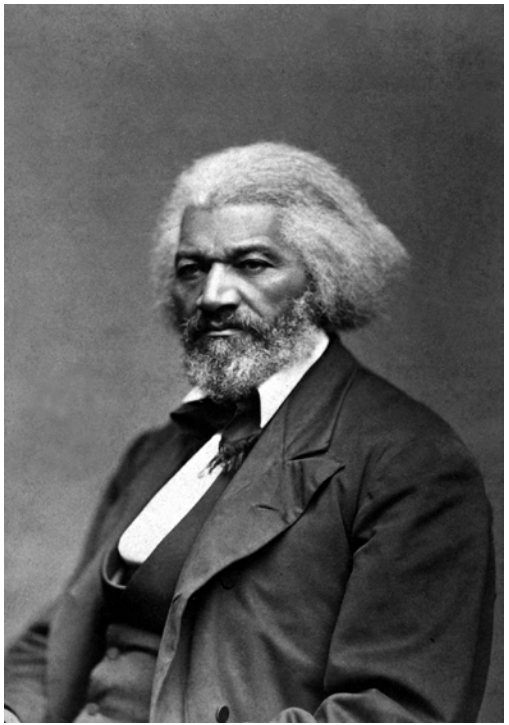
Should the Olympics be Divided into Men's and Women's Events?

Silent Written Response:

- Should the Olympics be divided into Men’s and Women’s Events?
- Explain your reasoning.



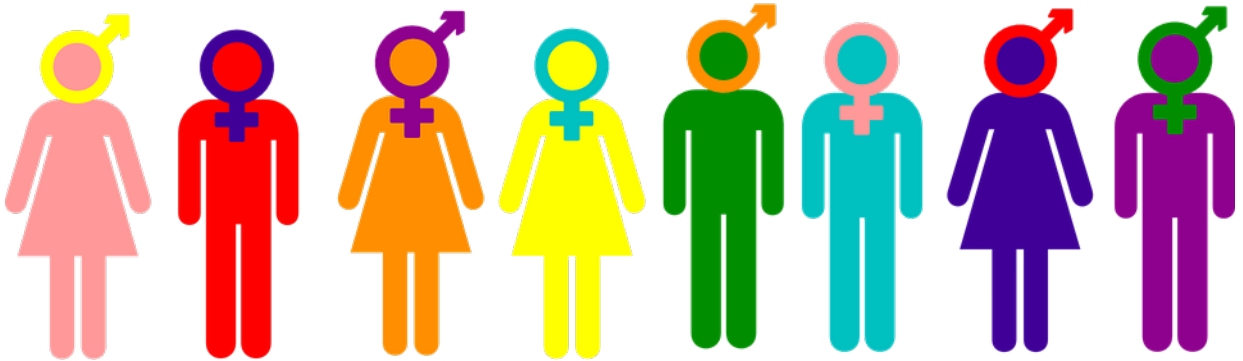
DISCUSS with your elbow partner: What makes a woman not a man?



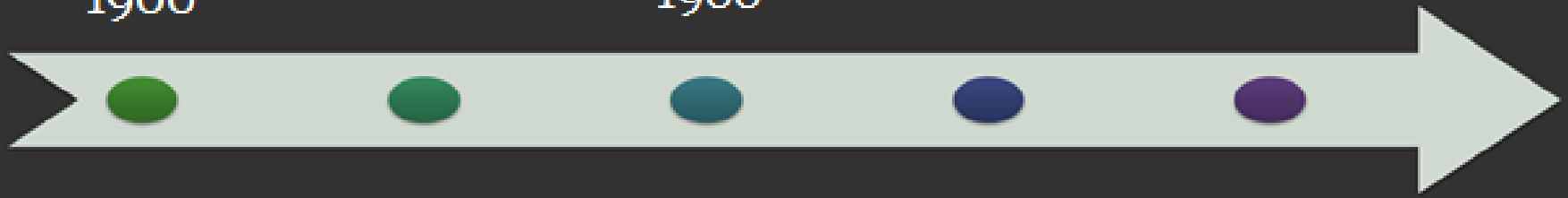
- Is it physical appearance?
- Is it biology?
- Is it identity?

<u>ESSENTIAL QUESTION:</u> Can we determine who is a “woman” and who is a “man” using our knowledge of biological sex development?

The International Association of Athletics Federations (IAAF) and the International Olympics Committee (IOC) are trying to figure that out...



Timeline of Sex Verification in Sports



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

1900

1960's

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

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

1988

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.

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

2015-Now

Meet Dutee Chand - Olympic Runner

For years, Dutee Chand has fought for the right to continue competing in women’s sports.

Dutee was banned from competing against other women due to her naturally high testosterone levels.

"I cried for three straight days after reading what people were saying about me. They were saying, 'Dutee, Boy or Girl?' and I thought, how can you say those things? I have always been a girl."

Is Biological Sex Differentiation an “Either/Or” Situation?

EXPLORE: On your own or with your teacher, use the following interactives to learn more about the complexities of biological sex differentiation. Fill in the flowchart as you work through.

Sexual Differentiation

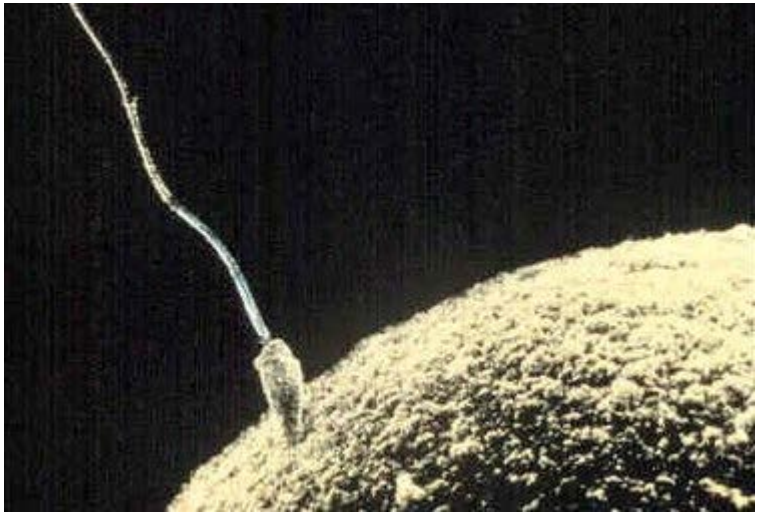
Chromosomal Sex

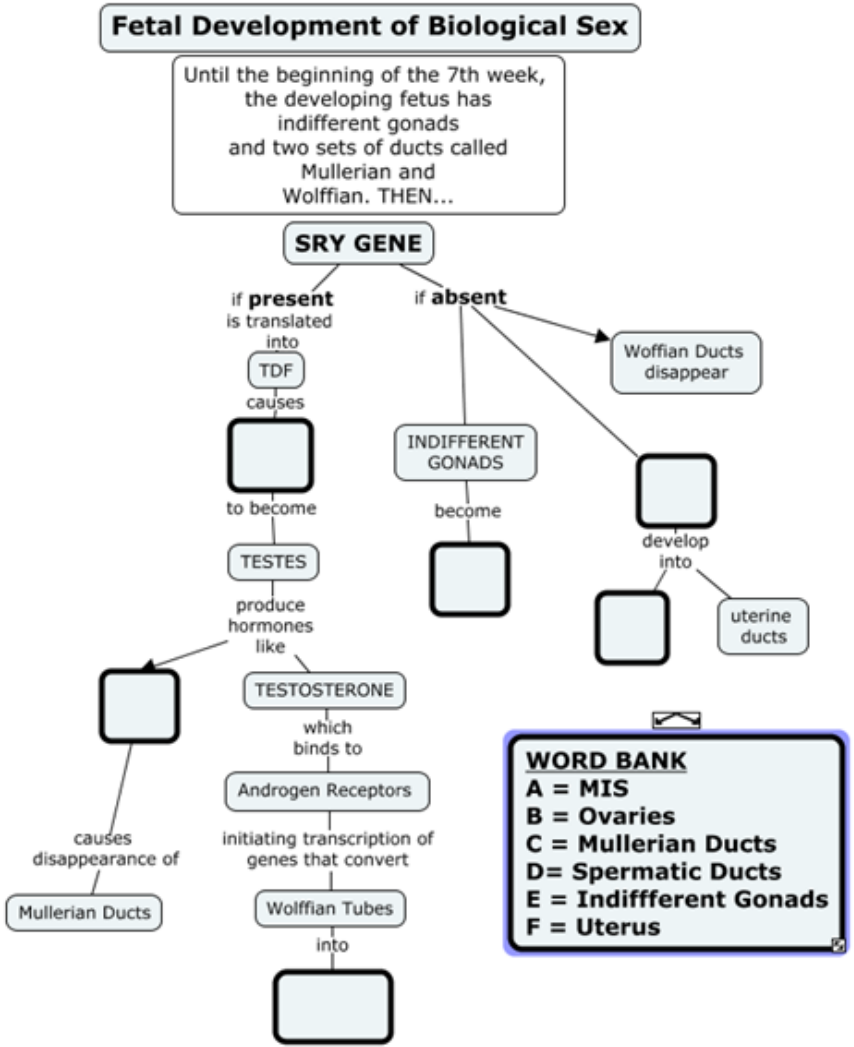
Gonadal Sex

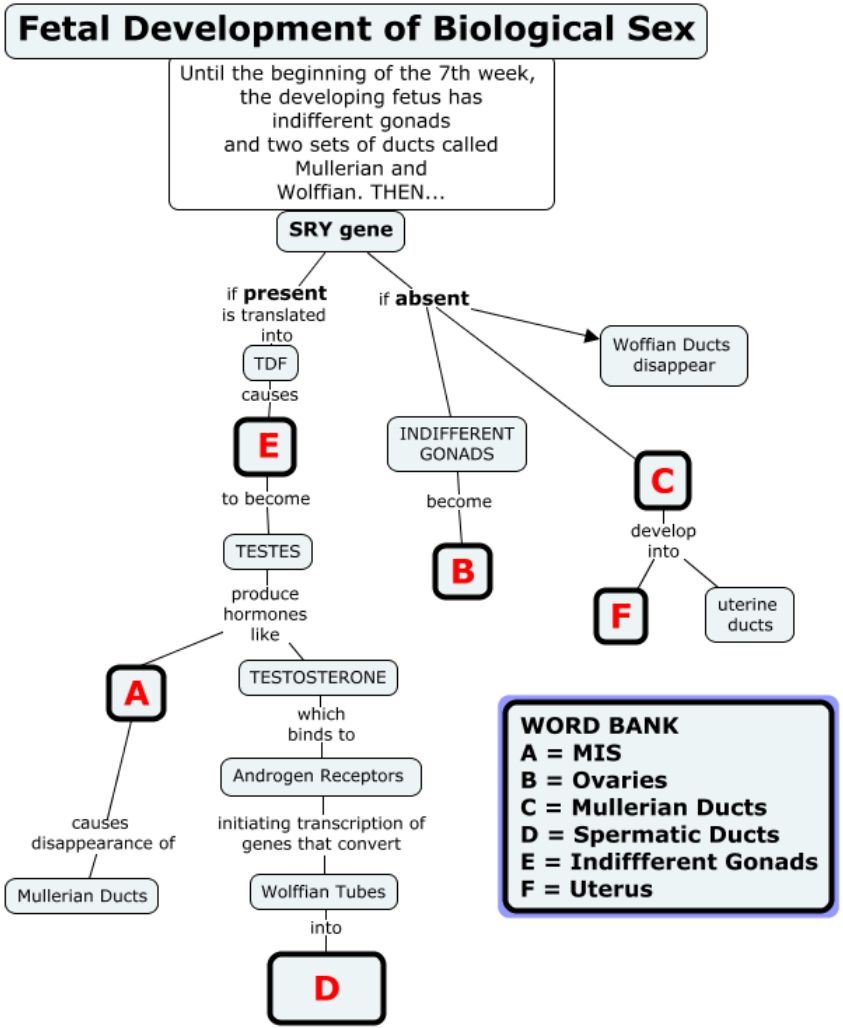
Duct Differentiation

AIS/5ARD How Androgens Work

Want to go deeper?
The Androgen Receptor
5-Alpha-Reductase and DHT




Fetal Development of Biological Sex
Until the beginning of the 7th week, the developing fetus has indifferent gonads and two sets of ducts called Mullerian and Wolffian. THEN...
SRY GENE
if present is translated into
TDF
causes
to become
TESTES
produce hormones like
TESTOSTERONE
which binds to
Androgen Receptors
initiating transcription of genes that convert
Wolffian Tubes
into
causes disappearance of
Mullerian Ducts
if absent
Woffian Ducts disappear
INDIFFERENT GONADS
become
develop into
uterine ducts
WORD BANK
A = MIS
B = Ovaries
C = Mullerian Ducts
D= Spermatic Ducts
E = Indiffferent Gonads
F = Uterus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D
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INDIFFERENT GONADS
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B
C
develop into
F
uterine ducts
WORD BANK
A = MIS
B = Ovaries
C = Mullerian Ducts
D = Spermatic Ducts
E = Indiffferent Gonads
F = Uterus

EXPLAIN

While reading your assigned article, note the karyotype, gene/chromosome, and genetic process associated with your variation.

Also, consider which of these images you would use to help illustrate the article.

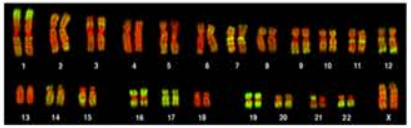
X0 Karyotype A

1

XY Karyotype B

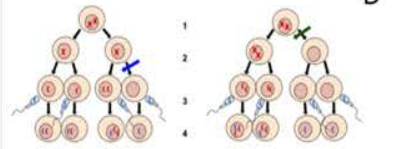
2

XX Karyotype C



3

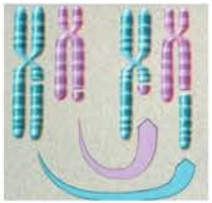
Nondisjunction D



1. Meiosis I 2. Meiosis II 3. Fertilization 4. Zygote The left image at the blue arrow is nondisjunction taking place during meiosis II. The right image at the green arrow is nondisjunction taking place during meiosis I. Nondisjunction is when chromosomes fail to separate normally resulting in a gain or loss of chromosomes

4

Translocation E

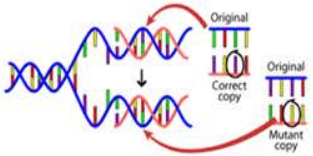


5

Typical Location of SRY Gene F

6

DNA Replication Mistake G



7

X-Linked Inheritance of AR Gene H

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

8

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.

	Turner Syndrome	Swyer Syndrome	46, XX testicular development	Androgen Insensitivity Syndrome
A				
B		Individuals exhibit typical male karyotype but atypical sex characteristics.		
C				
D				
E				

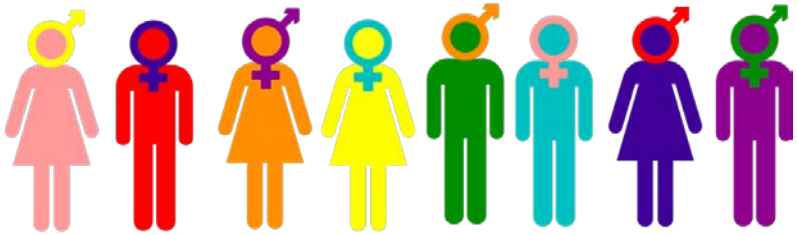
ELABORATE

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.

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

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/)



CONCLUDE: 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.

Dutee grew up one in a small village in India. Dutee lived with her parents and six siblings in a mud hut with unreliable electricity and no water. Dutee's parents do not read.

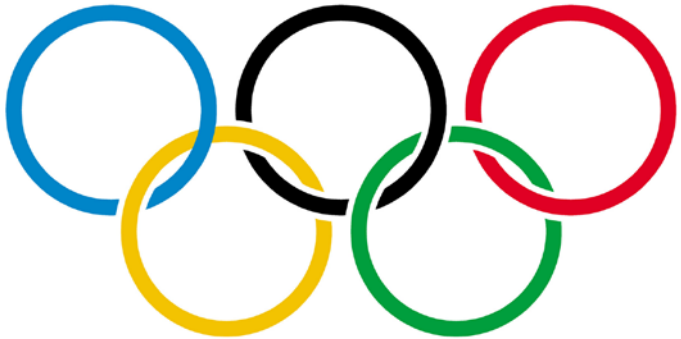
Outstanding Athletes like Dutee are often gifted with extra food and meat to keep them healthy when their home diets need to be supplemented.

Sleep on This:

What other factors (inherited or otherwise) could affect athletic advantage?

- Genes affecting height?weight?muscle formation and mass?
- Childhood Diet and Nutrition?
- Environment?

How could the International Olympic Committee test these factors scientifically?



Links to Jigsaw Articles

Teacher: Print enough **jigsaw articles 1-4** –so that each one of four group members has a different article to read.

- **Article 1 – Turner Syndrome https://ghr.nlm.nih.gov/condition/turner-syndrome**
- **Article 2 – Swyer Syndrome https://ghr.nlm.nih.gov/condition/swyer-syndrome**
- **Article 3 – 46XX Testicular Disorder of Sex Development https://ghr.nlm.nih.gov/condition/46xx-testicular-disorder-of-sex-development#genes**
- **Article 4 – Androgen Insensitivity Syndrome https://ghr.nlm.nih.gov/condition/androgen-insensitivity-syndrome**

Teacher - If students have online access, post these **interactive links** for students.

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

Chromosomal Sex - http://www.aboutkidshealth.ca/En/HowTheBodyWorks/SexDevelopmentAnOverview/SexualDifferentiation/Pages/ChromosomalSex.aspx

Gonadal Sex: http://www.aboutkidshealth.ca/En/HowTheBodyWorks/SexDevelopmentAnOverview/SexualDifferentiation/Pages/GonadalSex.aspx

Duct Differentiation: http://www.aboutkidshealth.ca/En/HowTheBodyWorks/SexDevelopmentAnOverview/SexualDifferentiation/Pages/DuctDifferentiation.aspx

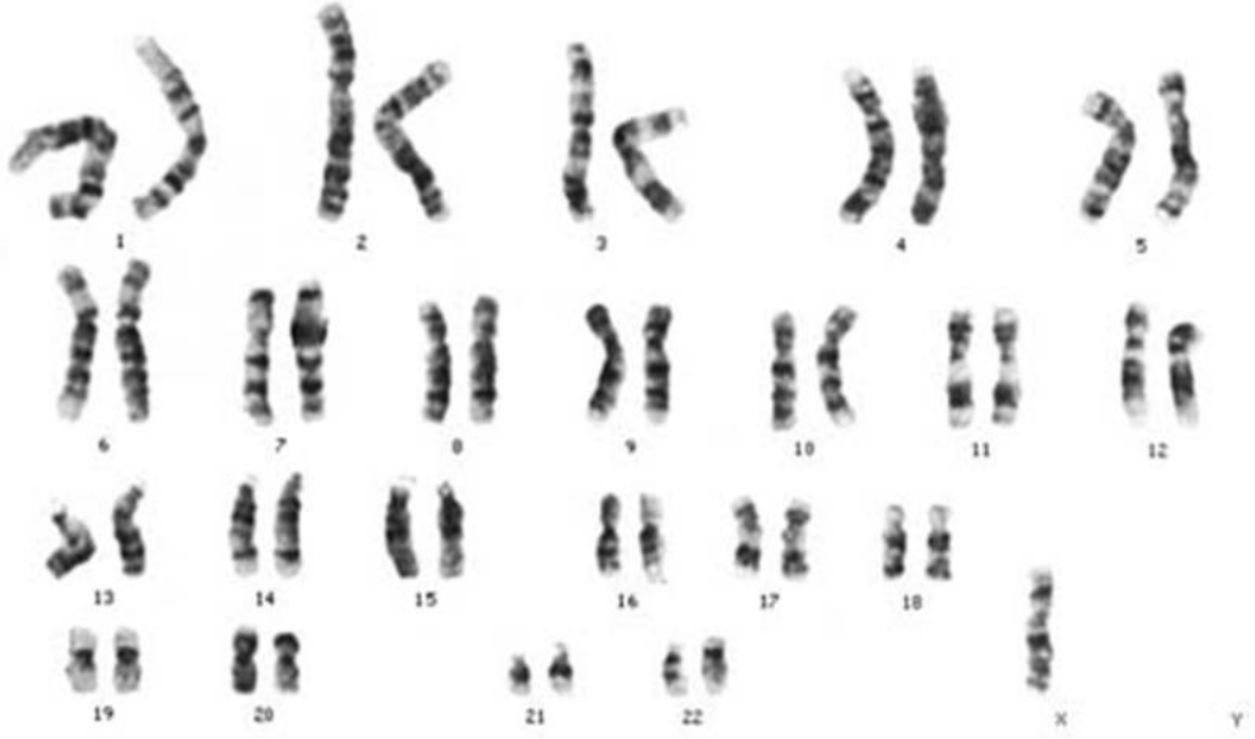
AIS/5ARD How Androgens Work: http://www.aboutkidshealth.ca/En/HowTheBodyWorks/SexDevelopmentAnOverview/AISand5ARD/Pages/HowAndrogensWork.aspx
The Androgen Receptor: http://www.aboutkidshealth.ca/En/HowTheBodyWorks/SexDevelopmentAnOverview/AISand5ARD/Pages/TheAndrogenReceptor.aspx

5-Alpha-Reductase and DHT: http://www.aboutkidshealth.ca/En/HowTheBodyWorks/SexDevelopmentAnOverview/AISand5ARD/Pages/5-Alpha-ReductaseandDHT.aspx

Teacher – Optional Print one set of **Image Cards A-H** (Slides 21-28) per four student group.

X0 Karyotype

A

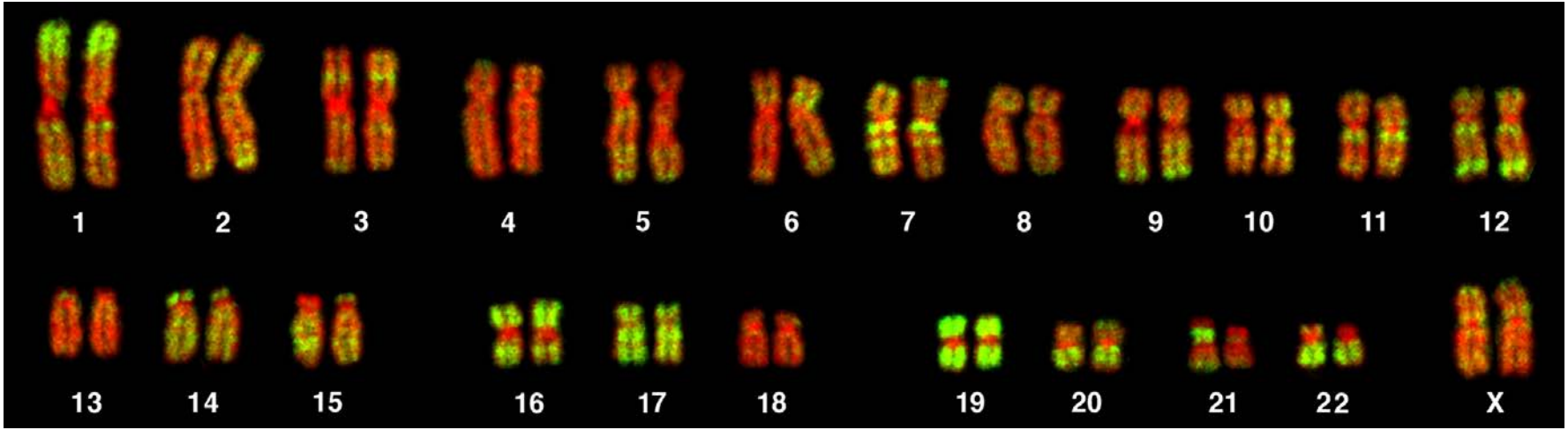


XY Karyotype

B

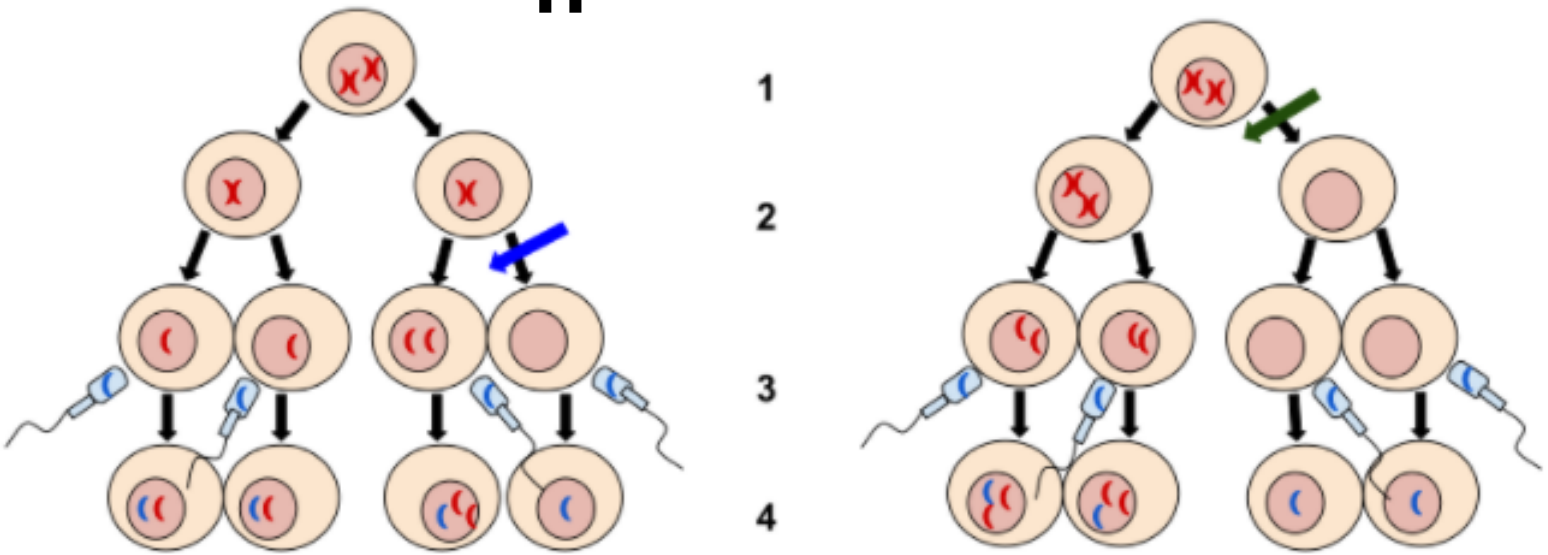
XX Karyotype

C



Nondisjunction

D



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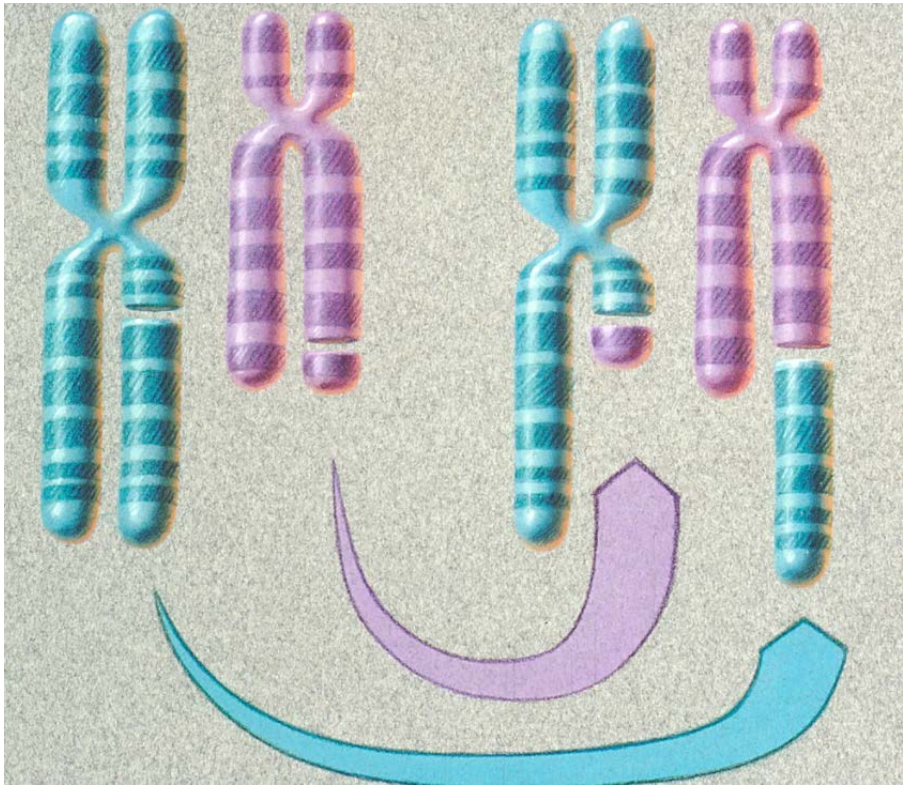
Translocation

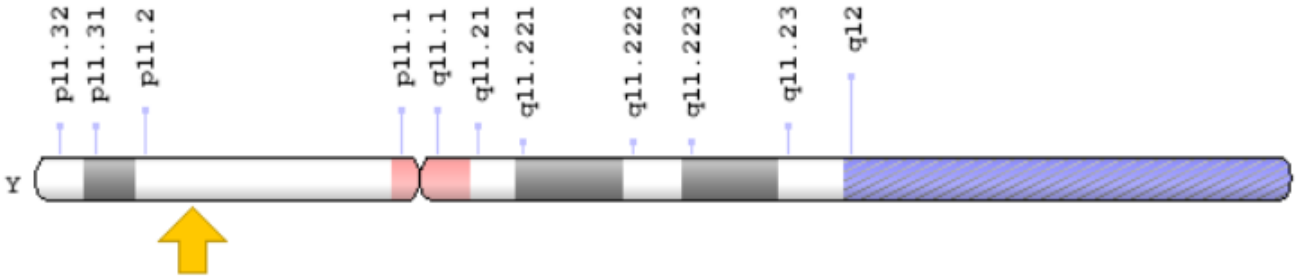
E



Typical Location of SRY Gene

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)

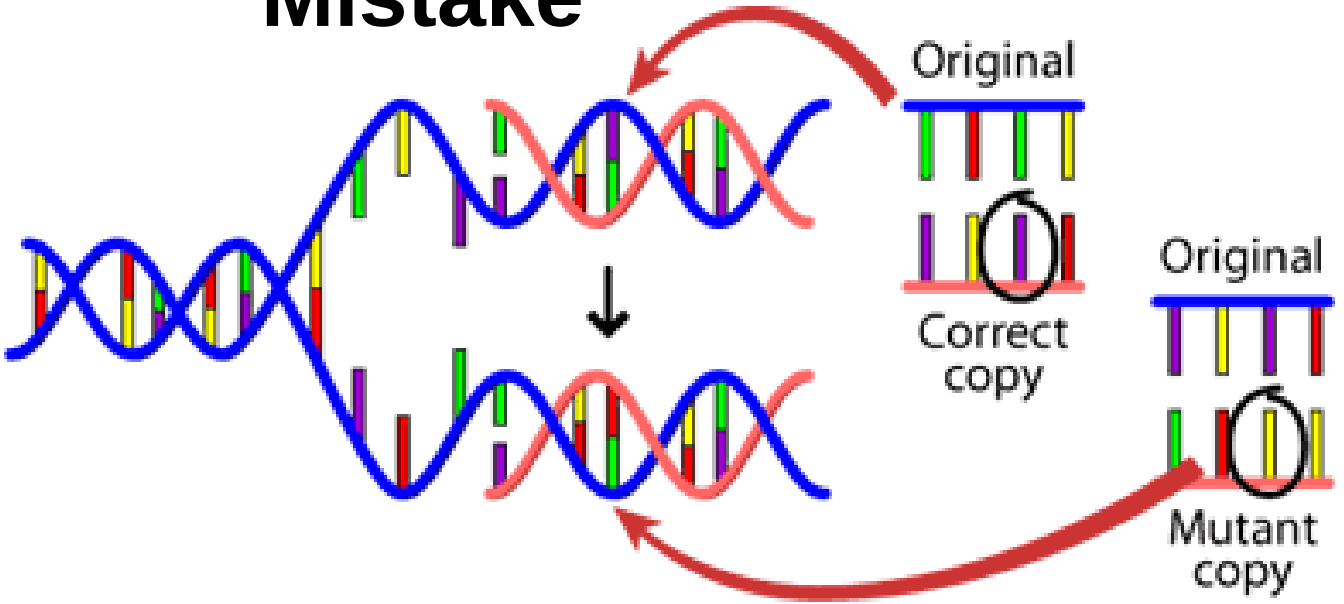


Credit: Genome Decoration Page/NCBI

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^{a}_{r}	$X^{AR}X^{a}_{r}$	$X^{a}_{r}Y$