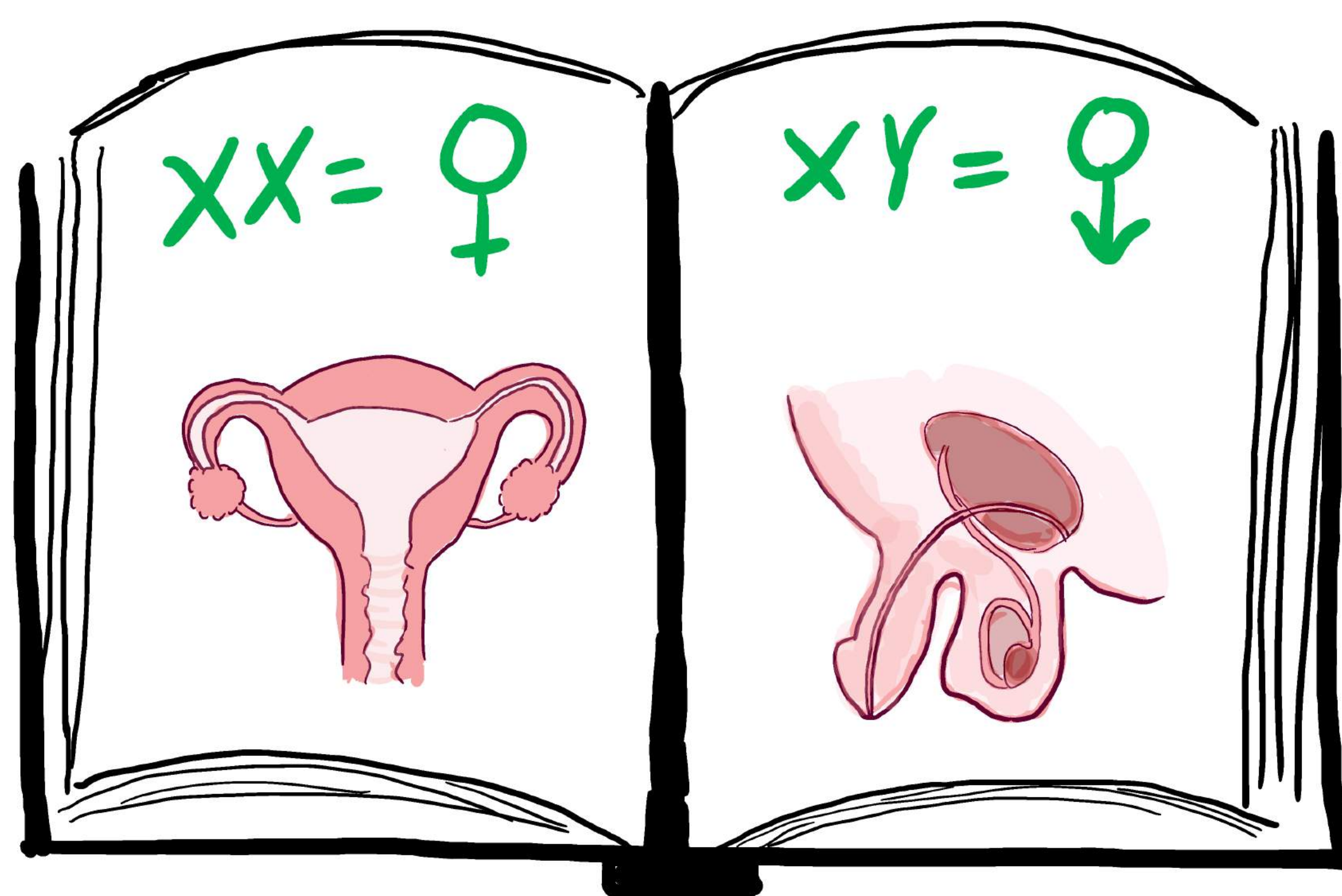


THIS IS A BOOKLET ABOUT  
TRANSGENDER IDENTITIES AS TOLD BY



IN SCHOOL, MOST OF US ARE  
TAUGHT A VERY BASIC UNDERSTANDING  
OF SEX AND GENDER.

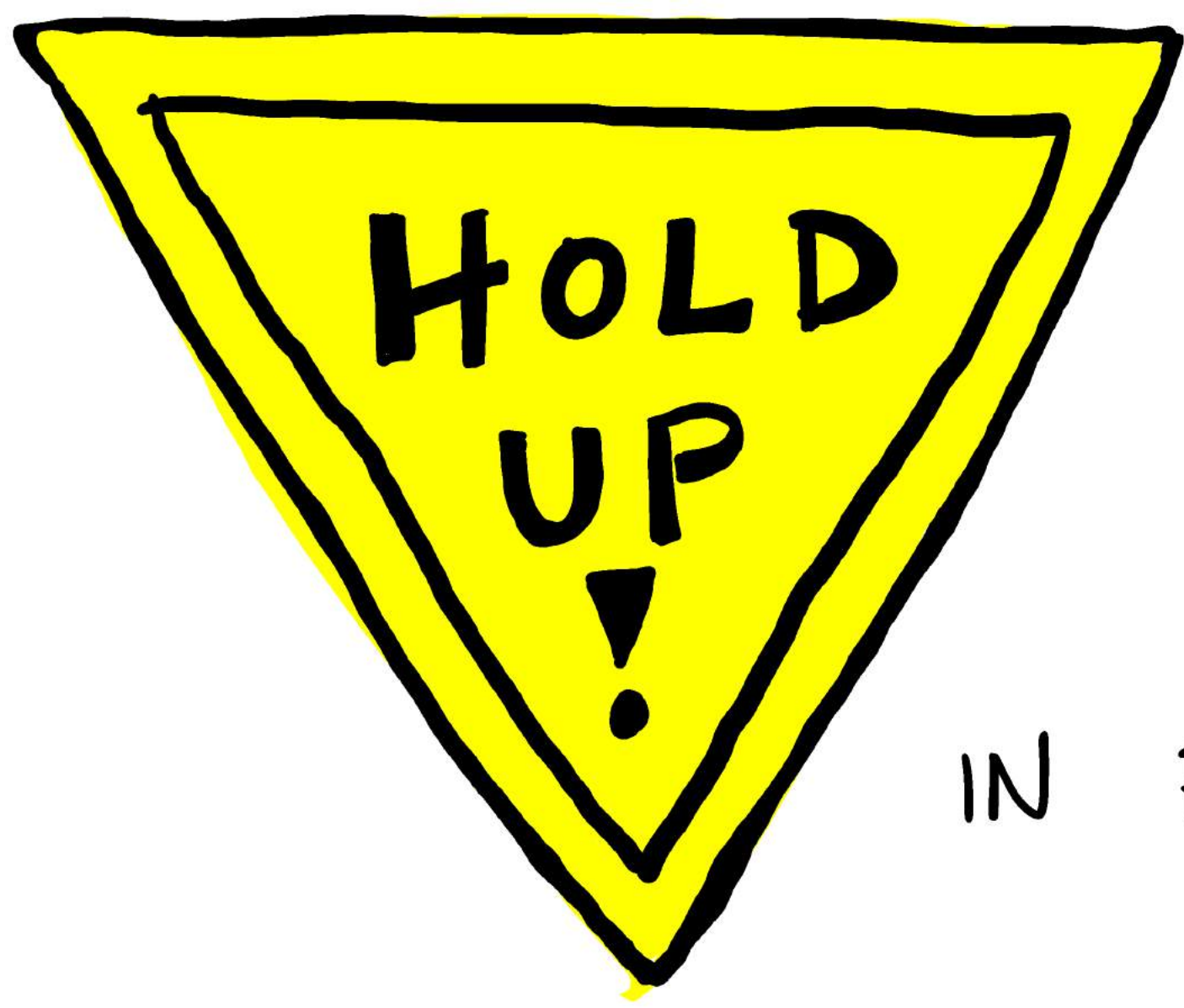


THIS IS AN OKAY GENERALIZATION, BUT  
AS BIOLOGISTS WILL TELL YOU, IT IS  
WOEFULLY INCOMPLETE. SO, SCIENCE FANS...

 LET'S GET SCIENTIFIC! 

CV Vitolo-Haddad  
University of Wisconsin-Madison





BEFORE WE JUMP IN, THERE  
ARE A FEW TERMS WORTH DEFINING.  
IN PARTICULAR, I USE "GENDER" DIFFERENTLY  
THAN SOME READERS ARE USED TO.

SOME FOLKS THINK ABOUT "SEX" AND "GENDER" AS  
SEPARATE. THEIR REASONING GOES LIKE THIS:

**SEX** DESCRIBES ANATOMY - REPRODUCTIVE ORGANS,  
CHROMOSOMES, AND SECONDARY SEX CHARACTERISTICS.

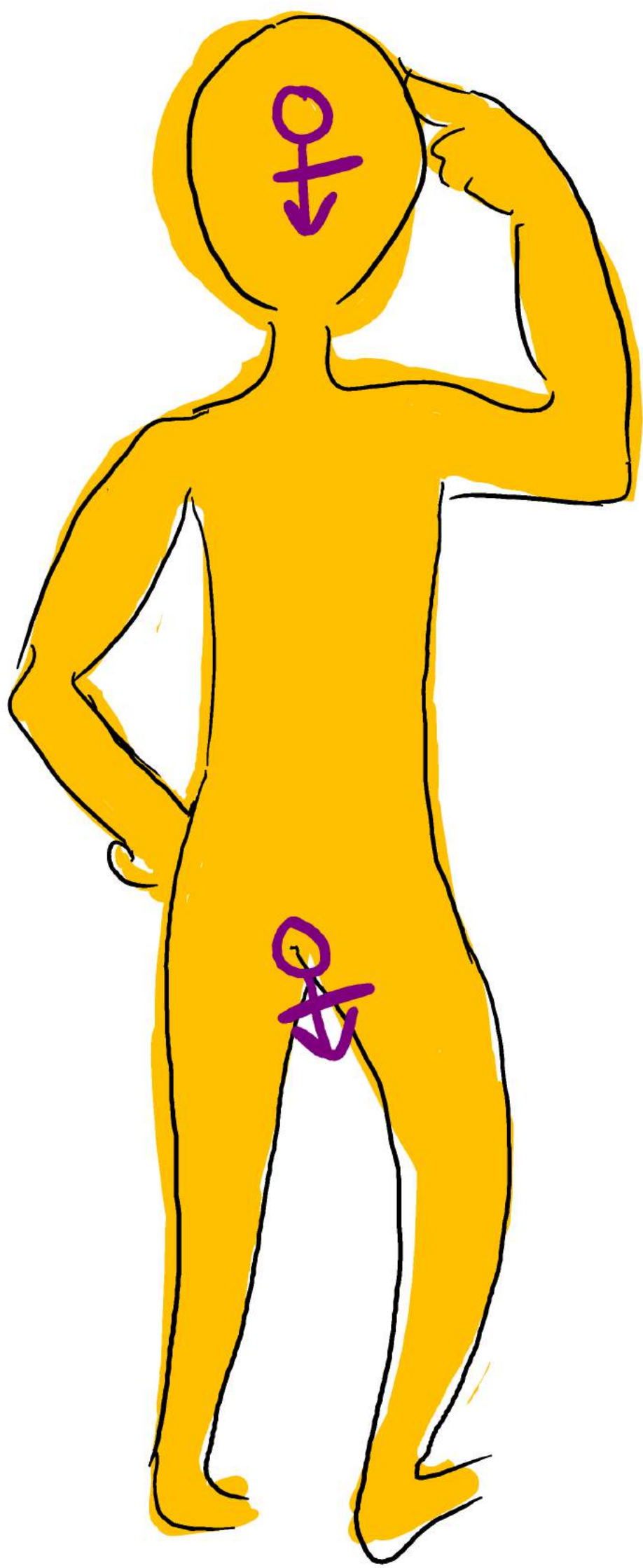
EXAMPLES OF SEXES INCLUDE MALE, FEMALE, AND  
INTERSEX (NEITHER MALE NOR FEMALE).

**GENDER** DESCRIBES SELF-IDENTIFICATION  
WITHIN SOCIAL ROLES - IT'S A COGNITIVE PROCESS.  
EXAMPLES OF GENDERS INCLUDE MAN, WOMAN, AND  
NONBINARY (NEITHER MAN NOR WOMAN).

I USE "GENDER" TO MEAN THE SET OF  
LABELS ONE USES TO DESCRIBE THEMSELVES -  
ANATOMICALLY AND COGNITIVELY.

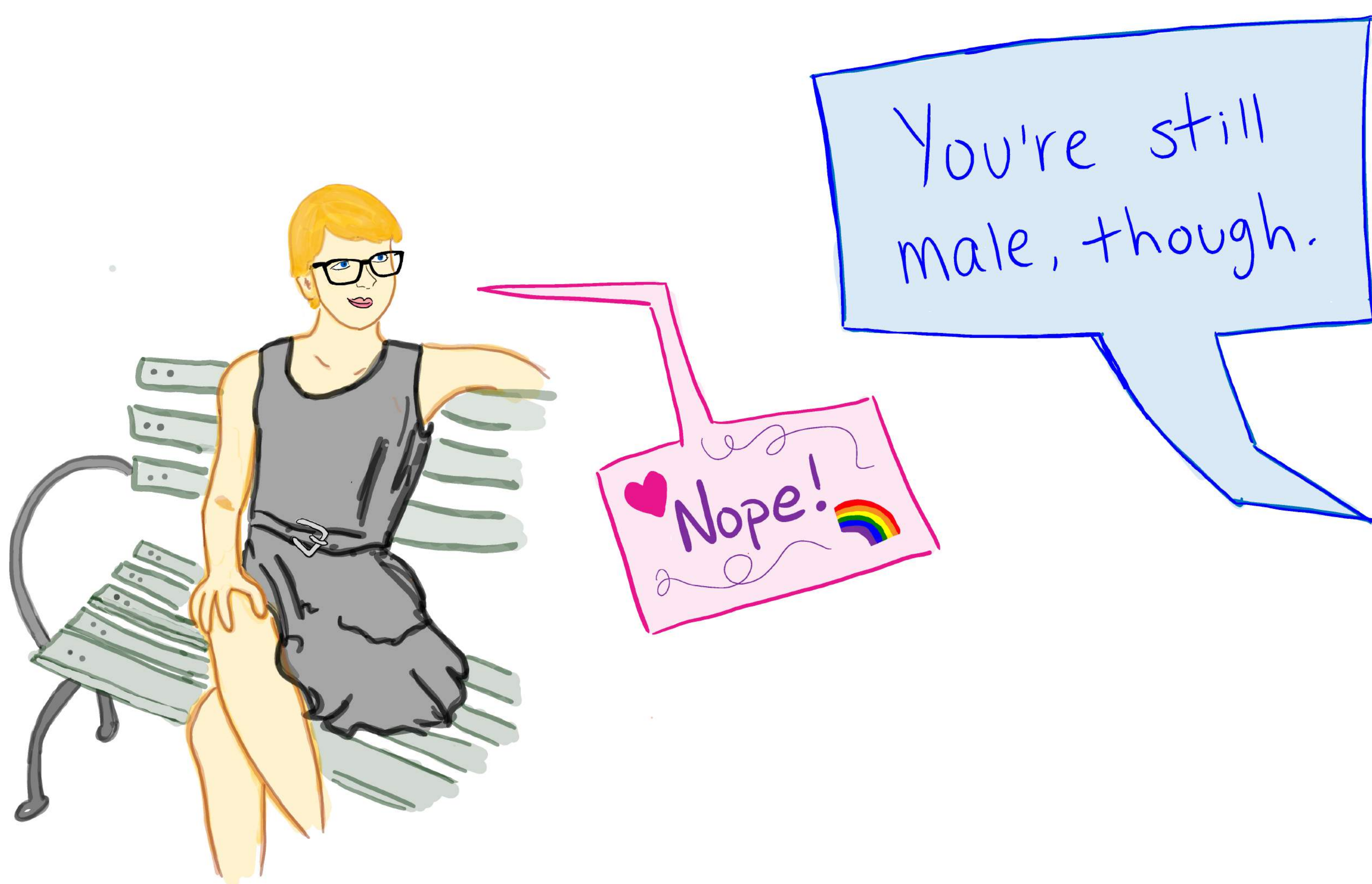


# Here's Why:



SEX, AS I WILL EXPLAIN, IS EVERY BIT AS ABSTRACT AS GENDER, AND ARBITRARY DIVISIONS BETWEEN SEX AND GENDER CREATE A STRANGE SEPARATION BETWEEN BODY AND MIND. THIS POSITS TRANS PEOPLE AS MISMATCHED, ILL, OR DEVIANT, WHEN NOT ALL FEEL "TRAPPED IN THE WRONG BODY." OTHER TRANSGENDER PEOPLE DO, AND PURSUE MEDICAL INTERVENTION. GIVEN WHAT BIOLOGISTS KNOW ABOUT SEX, BOTH OF THESE MAKE A LOT OF SENSE.

AND BESIDES, THIS SITUATION CAN FEEL INVALIDATING:



BECAUSE EVEN THOUGH MALE AND FEMALE AREN'T GENDERS, THEY ARE GENDERED WORDS.

gendered (adj): Relating to one particular gender.



OF COURSE, WORDS LIKE "UTERUS" AND "PROSTATE" ARE STILL USEFUL IN MEDICAL CONTEXTS, BUT THOSE ORGANS ALONE DON'T DEFINE A PERSON'S SEX (MORE ON THAT SOON!) AND THAT IS A CONVERSATION BETWEEN A DOCTOR AND PATIENT, WITH MANY WAYS TO NAVIGATE THOSE DISCUSSIONS.

BUT THAT'S A RABBIT HOLE WE CAN JUMP DOWN ANOTHER TIME!



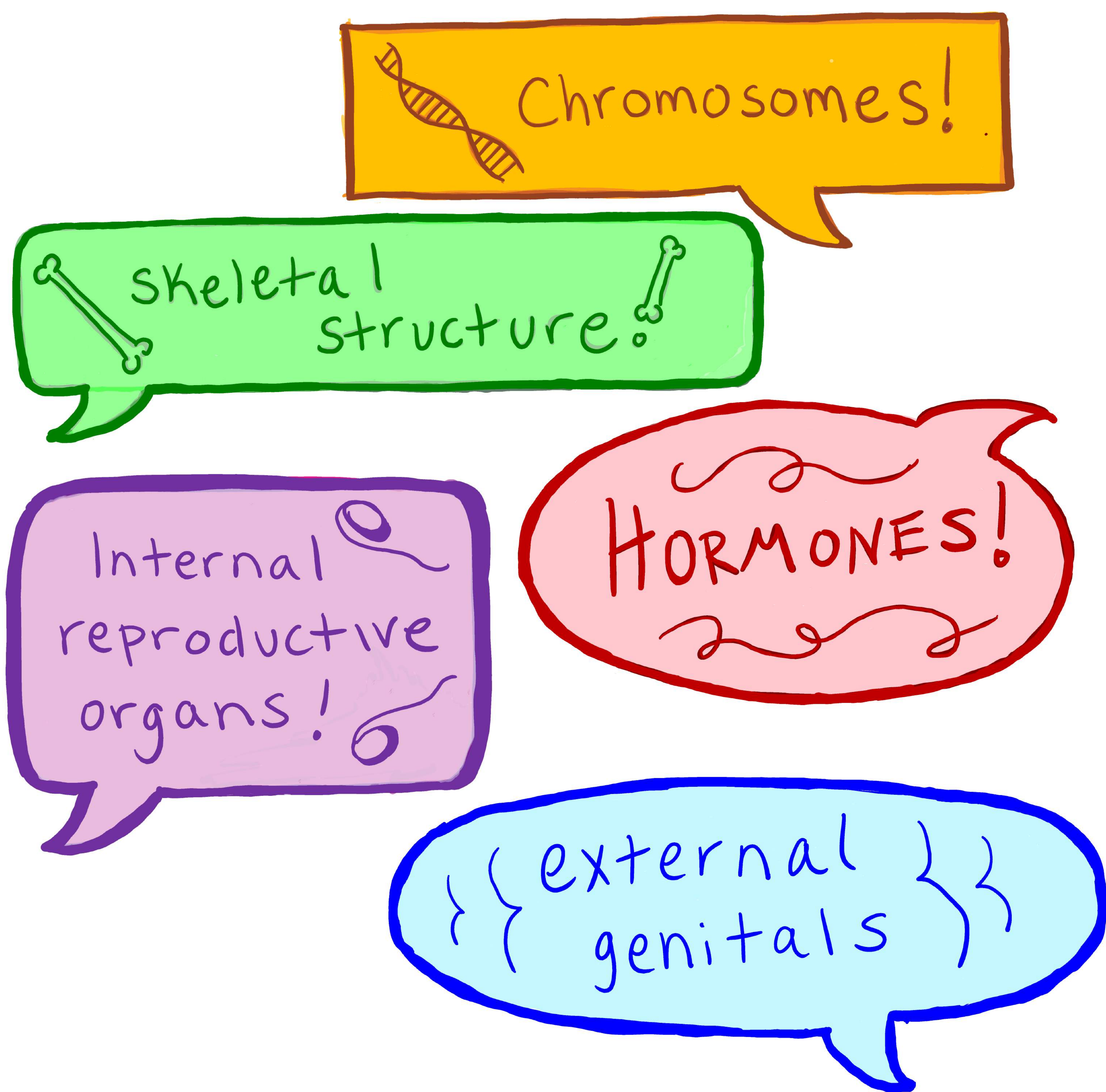
FOR MY PURPOSES HERE, I'LL USE "SEX" AND "GENDER" SOMEWHAT FLUIDLY, BECAUSE THEY ARE BOTH EXPRESSIONS OF ONE'S PERSONAL IDENTITY.

SO! WITHOUT FURTHER ADO:





IF THERE IS ONE THING MOST COMMONLY MISUNDERSTOOD ABOUT SEX AND GENDER, IT IS THAT SCIENTISTS HAVE A WAY TO "MEASURE" OR WORSE, "PROVE" SOMEONE'S SEX.



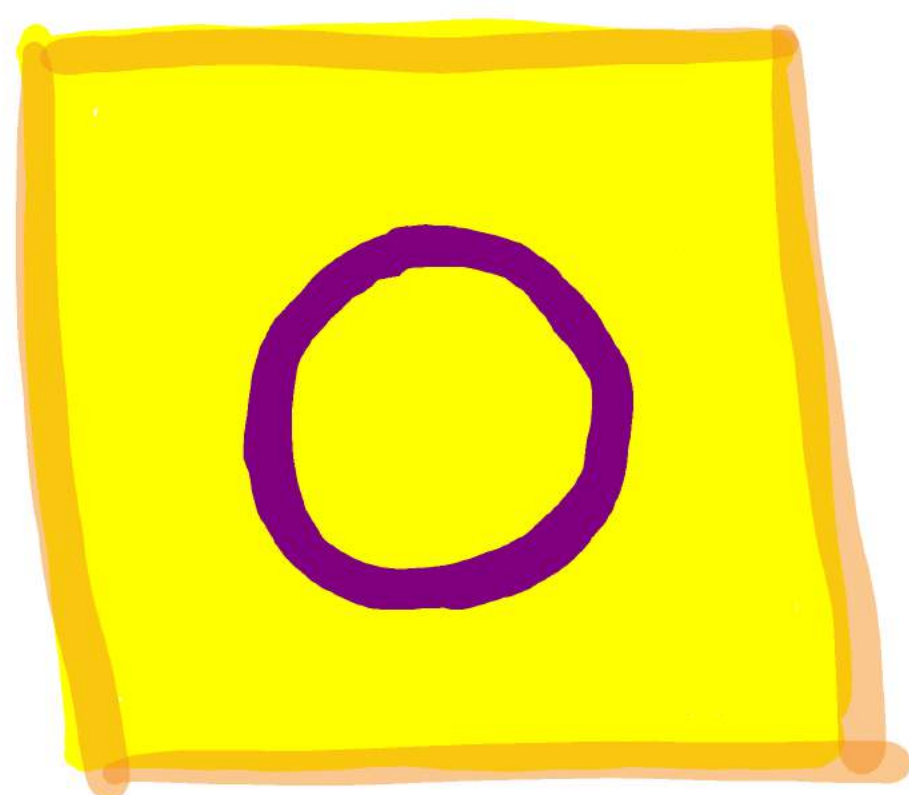
*... But in reality, there is no clear line between the sexes. Not even close.*





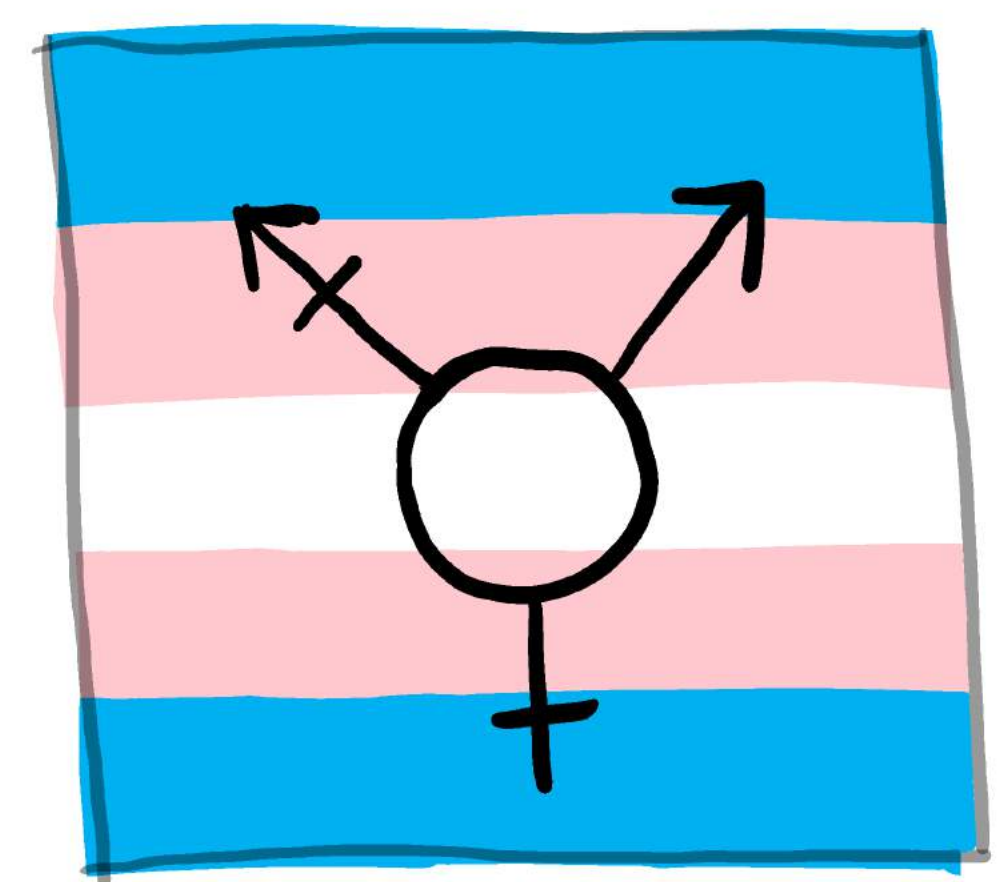
WE TYPICALLY ASSIGN SEX TO INFANTS BY OBSERVATION, BUT THIS IS DONE FOR EASE, NOT ACCURACY. THERE IS SIMPLY NO SINGLE CHARACTERISTIC THAT DETERMINES GENDER, AND WITH 350,000 BABIES BORN EACH DAY, EASE IS KEY.

BUT FOR SOME BABIES, THIS SYSTEM DOES A LOT OF HARM, FOR EXAMPLE:



**INTERSEX** BABIES HAVE AMBIGUOUS GENITALIA, AND MAY HAVE ELEMENTS OF MULTIPLE OR NO REPRODUCTIVE ORGANS. THEY ARE SUBJECTED TO DANGEROUS, **PURELY COSMETIC** SURGERIES TO ALTER THE APPEARANCE OF THEIR GENITALS, OFTEN WITHOUT TRULY INFORMED CONSENT FROM PARENTS.

**TRANSGENDER** PEOPLE ARE ASSIGNED THE INCORRECT SEX AT BIRTH, WHICH WOULDN'T BE AS BIG OF A DEAL IF THEY DID NOT FACE HUGE LEGAL HURDLES AND DISCRIMINATION IN ATTEMPTING TO CORRECT THE ERROR.

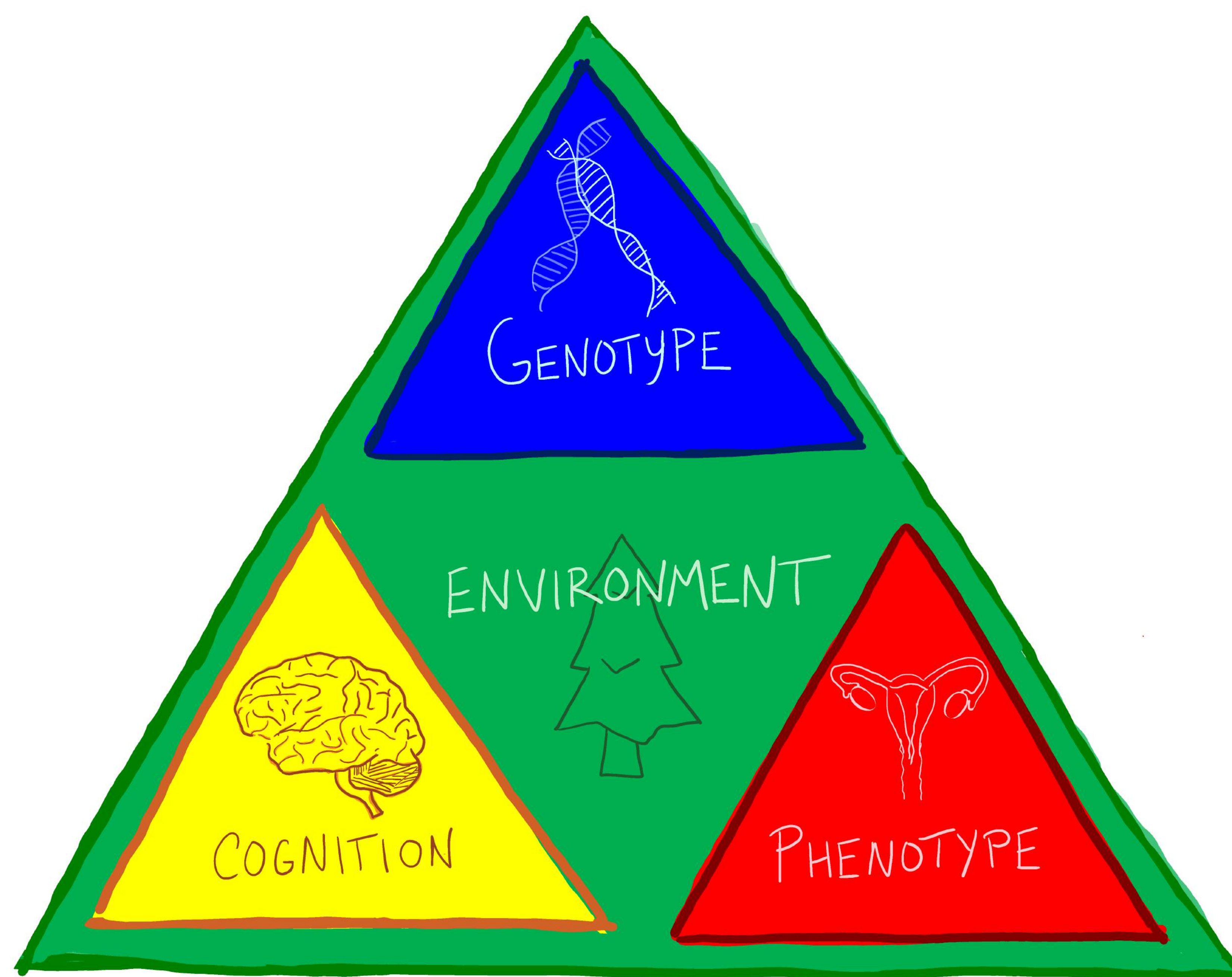


MUCH OF THIS HARM IS THE RESULT OF RUDAMENTARY OR INACCURATE UNDERSTANDINGS OF SEX.



A COMPREHENSIVE, SCIENTIFIC VIEW RECOGNIZES THAT GENDER AND SEX HAVE SUBJECTIVE ELEMENTS, MANY OF WHICH WE DON'T FULLY UNDERSTAND.

TO BIOLOGISTS, THEN, HUMAN GENDER IS A BEAUTIFULLY COMPLEX THING, DETERMINED BY A COMBINATION OF THESE FACTORS:



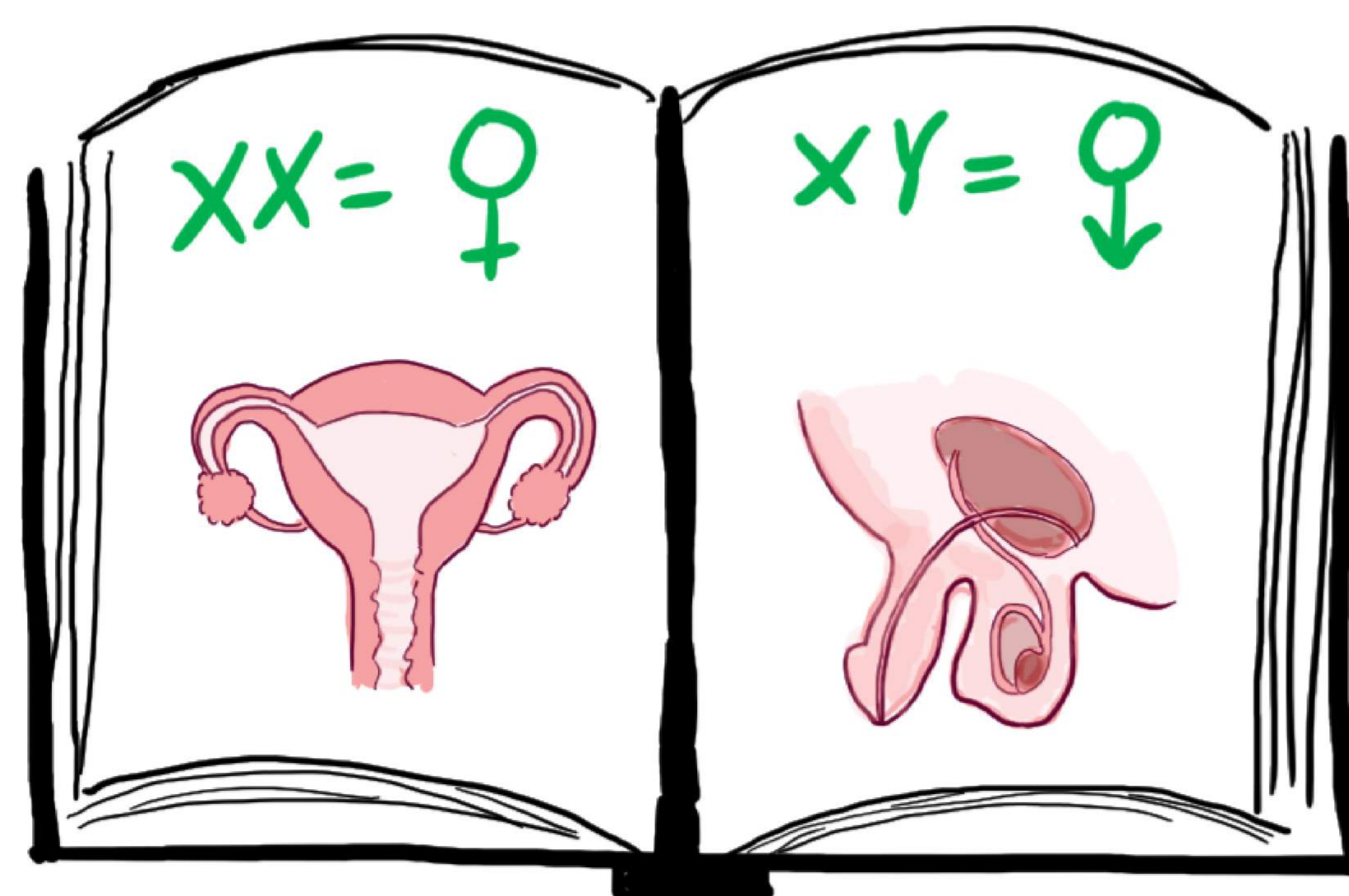
*& possibly more!*



WE'LL START WITH ...

**GENOTYPE**: an individual's genetic makeup, inherited during reproduction

IN BIOLOGY 101 WE LEARN THE BASICS  
REPRODUCTION, USING THE MOST COMMON  
GENOTYPES AND GENITALS AS AN EXAMPLE

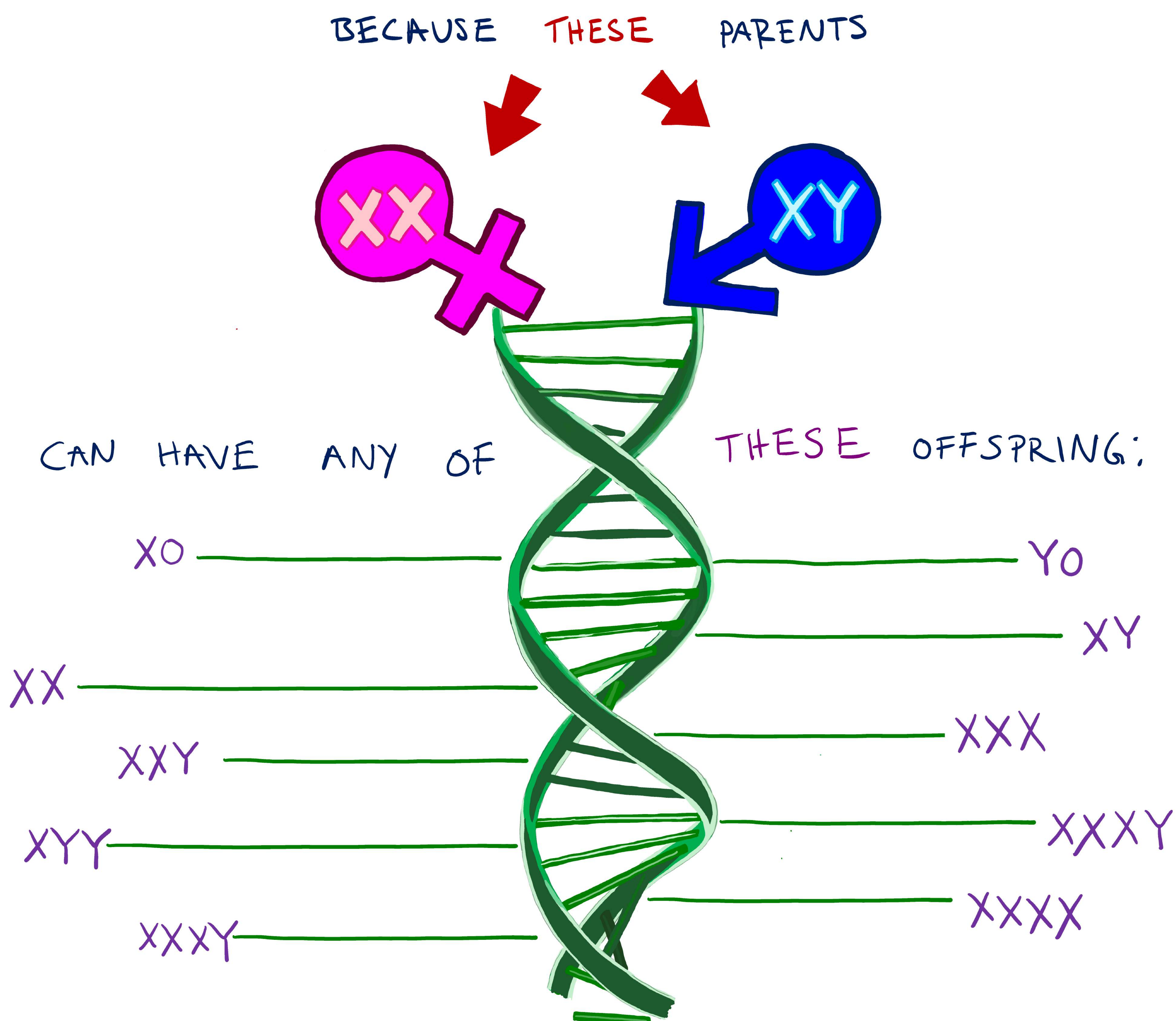


THIS IS NOT INTENDED AS  
AN EXHAUSTIVE LIST - JUST A  
DESCRIPTION OF THE MOST  
COMMON SCENARIO.





IN FACT, EVEN IF WE TAKE THE MOST  
COMMON SET OF PARENTS, THINGS GET  
*very* COMPLICATED, *very* QUICKLY,



AND THIS IS NOT SOME RARE ANOMALY - THE NATIONAL  
INSTITUTES OF HEALTH ESTIMATES 20-40 BABIES ARE  
BORN IN THE U.S. WITH XXY, XXXY, XYY, OR XXX

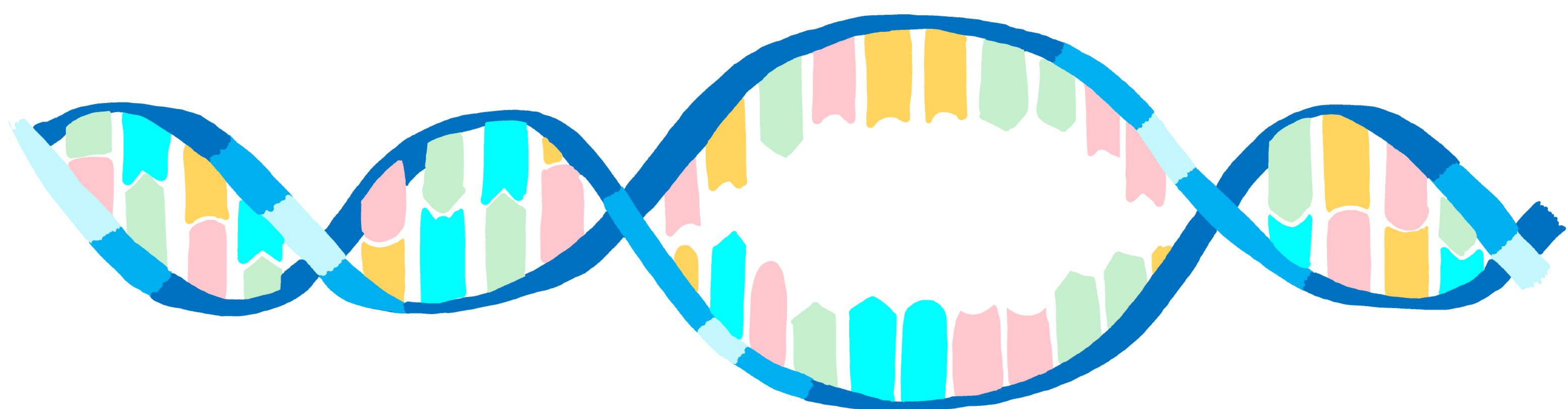
EVERY DAY!



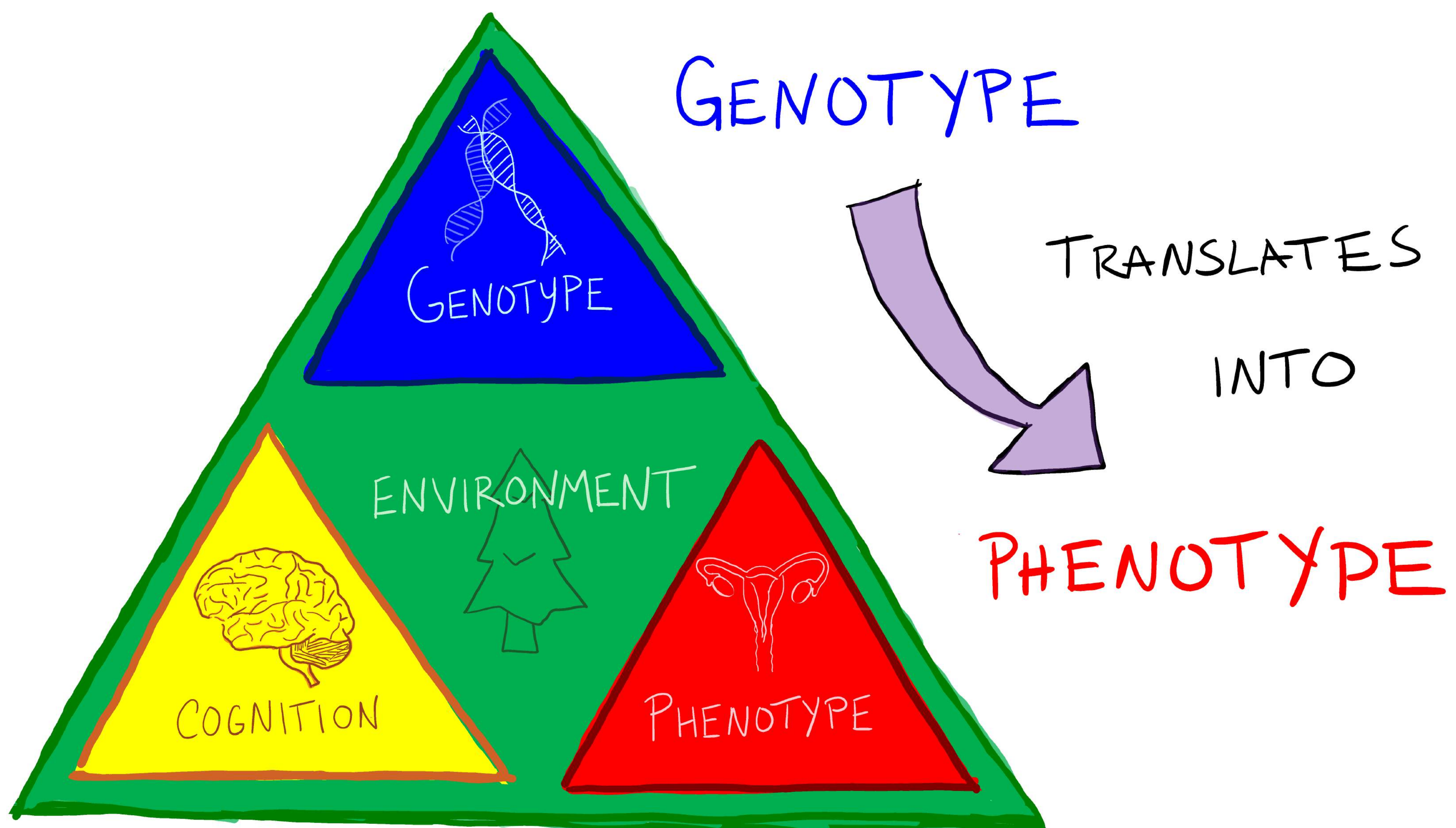
OKAY, SO THERE IS MORE GENETIC VARIANCE THAN YOU REALIZED. STILL, THAT MEANS CHROMOSOMES DETERMINE SEX, RIGHT? EVERYONE WITH **XX** WILL STILL HAVE A UTERUS AND VAGINA, AND EVERYONE WITH **XY** WILL HAVE A PENIS AND TESTICLES!



EVERY X AND Y CHROMOSOME IS UNIQUE, AND THAT GENETIC DIVERSITY MEANS THERE IS MORE OVERLAP BETWEEN THE GENOTYPES THAN YOU'D THINK. TO UNDERSTAND THIS, LET'S EXPLORE HOW DNA TRANSLATES INTO THE BODIES WE COME TO INHABIT.







**PHENOTYPE**: THE SET OF OBSERVABLE CHARACTERISTICS OF AN INDIVIDUAL RESULTING FROM THE INTERACTION OF ITS GENOTYPE WITH THE ENVIRONMENT

AND ANY  
GENOTYPE  
CAN PRODUCE  
ANY  
PHENOTYPE!

	vagina	uterus	penis	testicles	ambiguous
XX	✓	✓	✓	✓	✓
XY	✓	✓	✓	✓	✓
XXY	✓	✓	✓	✓	✓
XXX	✓	✓	✓	✓	✓
XXXY	✓	✓	✓	✓	✓

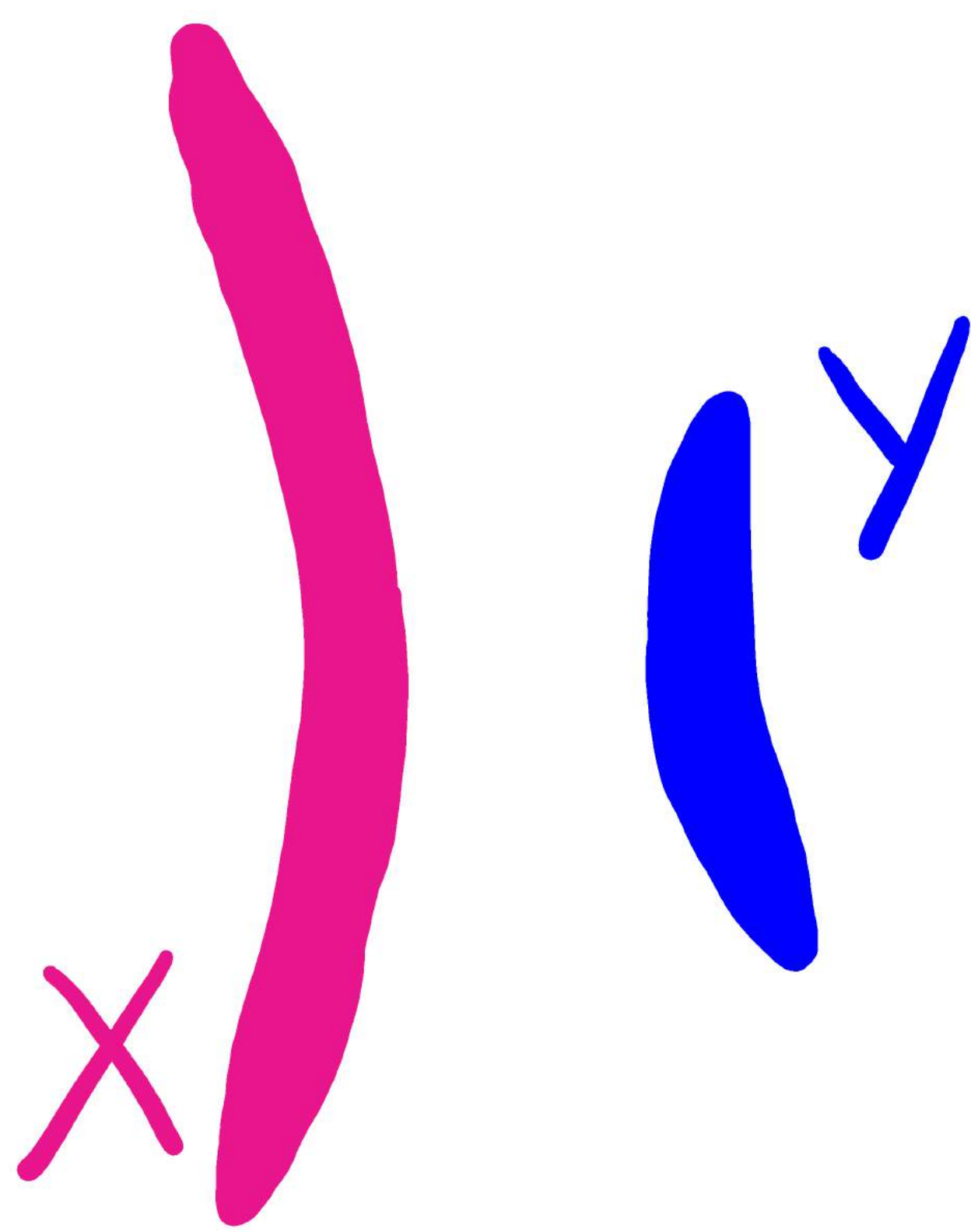


# For example...



THIS EMBRYO HAS AN  
**XX** GENOTYPE. THE MOST  
STATISTICALLY LIKELY  
PHENOTYPE IS A VAGINA/UTERUS

BUT SOME **X** CHROMOSOMES HAVE EVOLVED  
DIFFERENTLY, WHICH REQUIRES A QUICK PRIMER  
ON HUMAN REPRODUCTION TO EXPLAIN:



THE **X** CHROMOSOME CONTAINS  
800-900 GENES, WHILE THE  
**Y** CHROMOSOME, WHICH WAS  
ONCE A SIMILAR SIZE, NOW  
CONTAINS A MERE 50-70.

SOME EVOLUTIONARY BIOLOGISTS PREDICT THE  
**Y** CHROMOSOME WILL CONTINUE TO DETERIORATE,  
AND EVENTUALLY DISAPPEAR,  
BUT A 2012 STUDY ARGUED  
IT'S HERE TO STAY!<sup>1</sup>

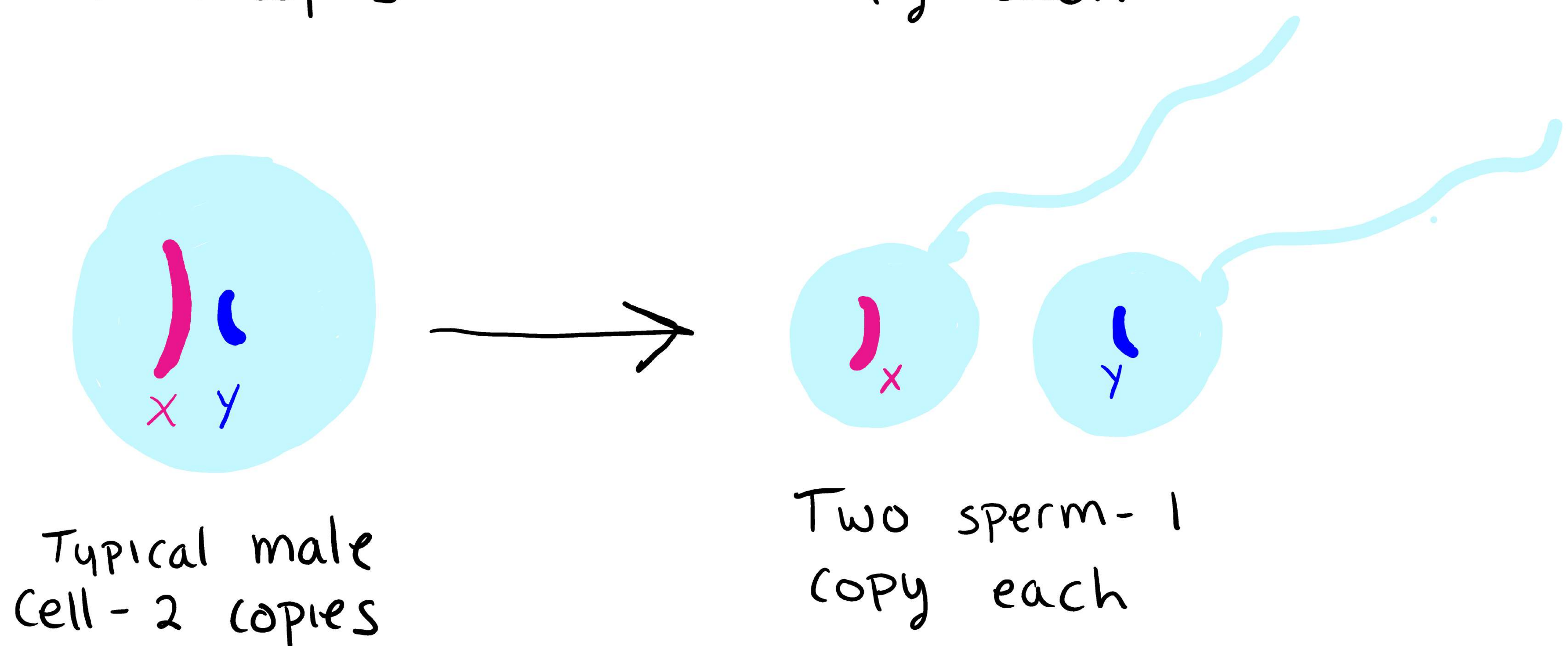
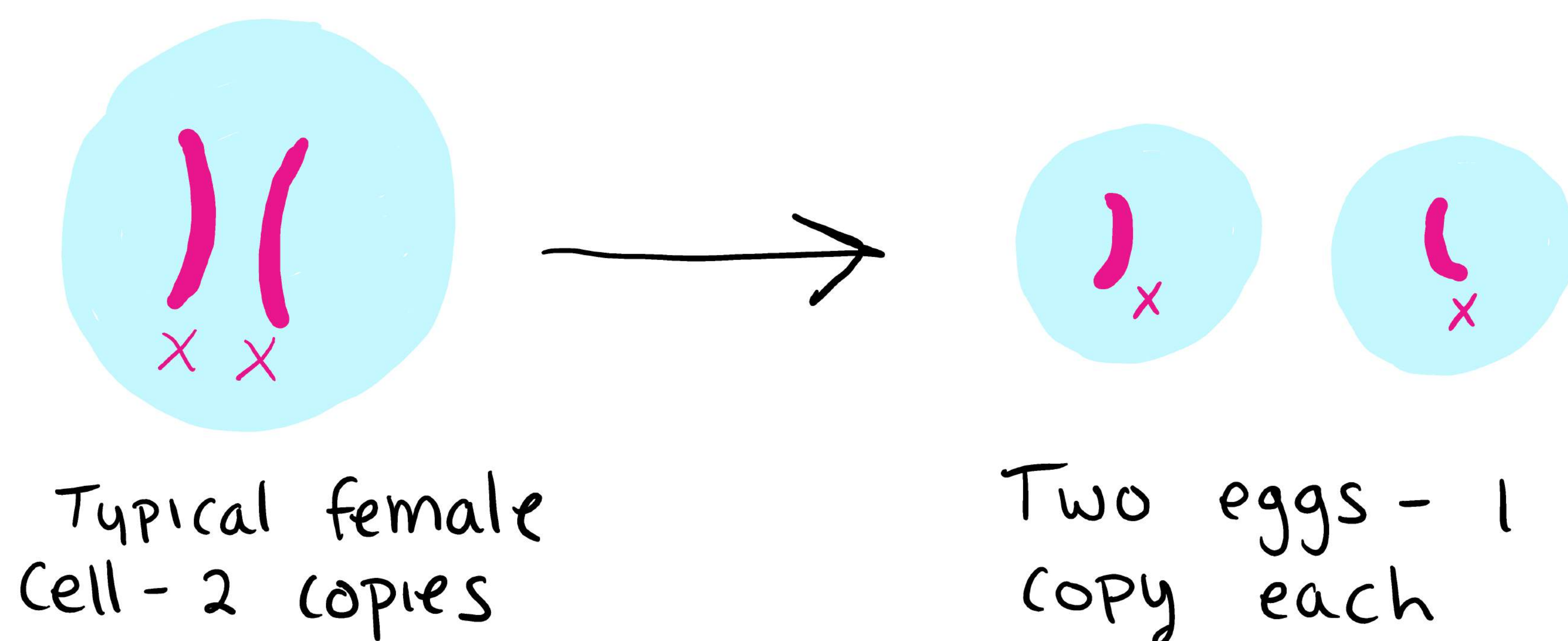


Hughes, Jennifer F., et al. "Strict evolutionary conservation followed rapid gene loss on human and rhesus Y chromosomes." Nature 483.7387 (2012): 82.

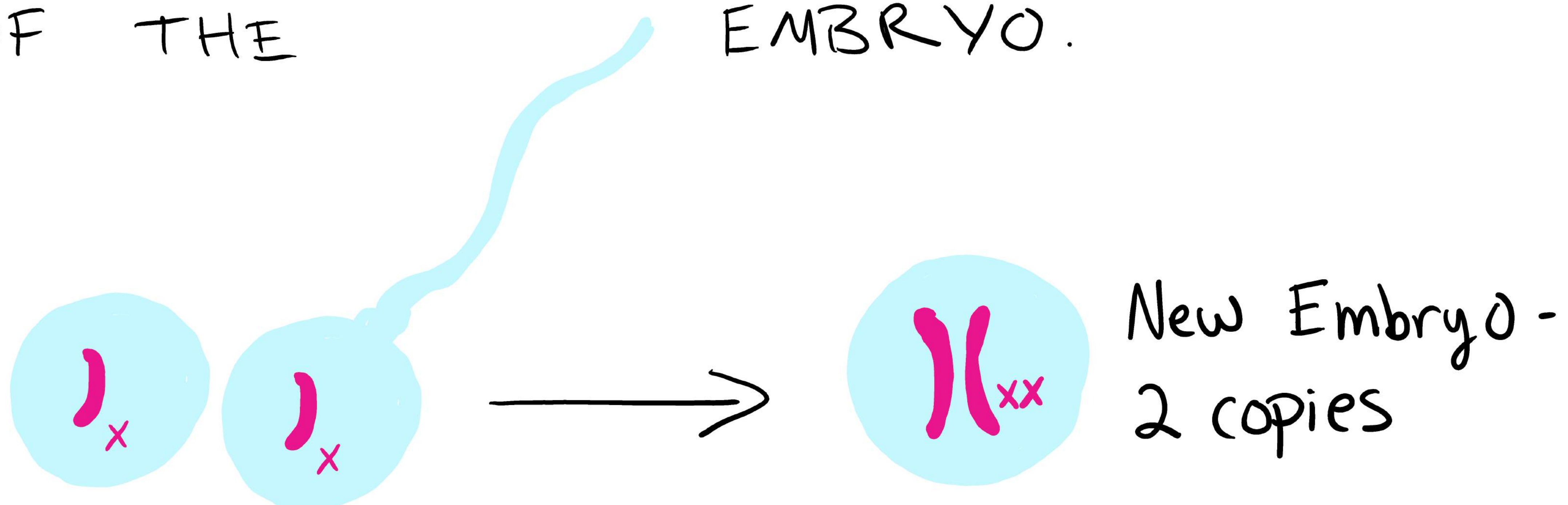
1. Hughes, Jennifer F., et al. "Strict evolutionary conservation followed rapid gene loss on human and rhesus Y chromosomes." Nature 483.7387 (2012): 82.



THE CELLS IN OUR BODY TYPICALLY CONTAIN 2 COPIES OF EACH CHROMOSOME - ONE FROM EACH PARENT. PARENT CELLS DIVIDE INTO SPERM AND EGGS, LIKE THIS:



THOSE COMBINE INTO THE GENOTYPE OF THE EMBRYO.

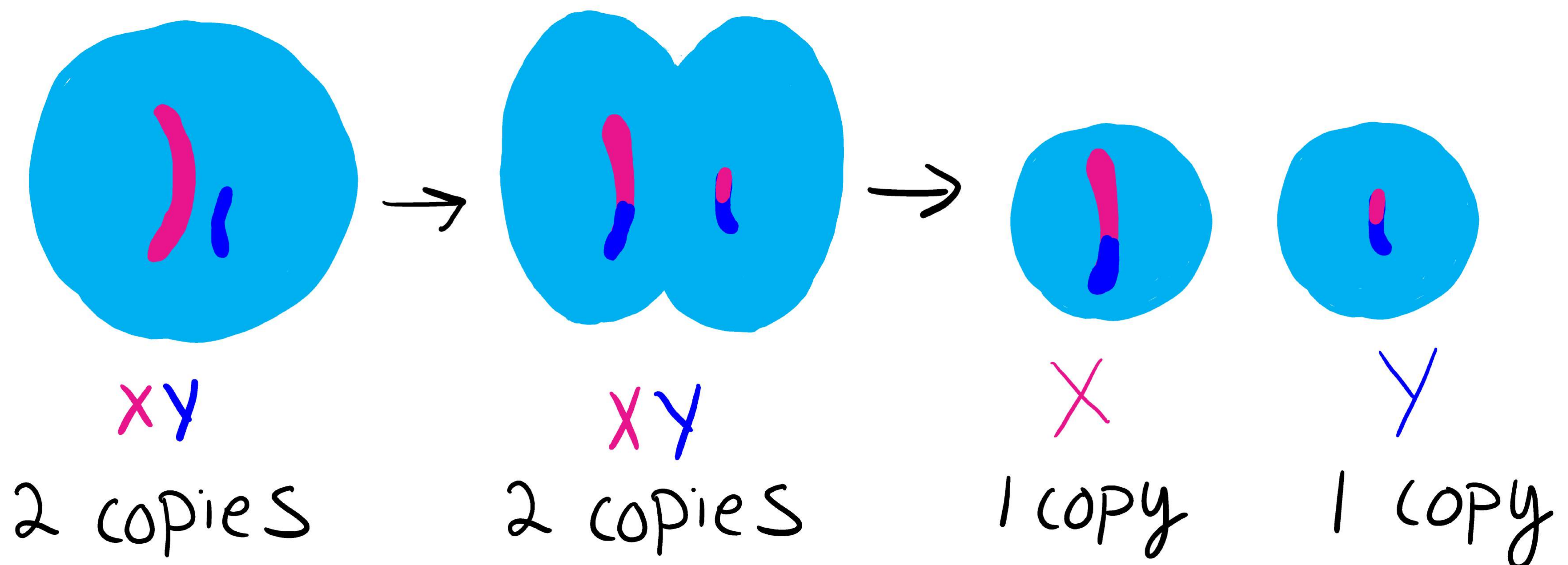




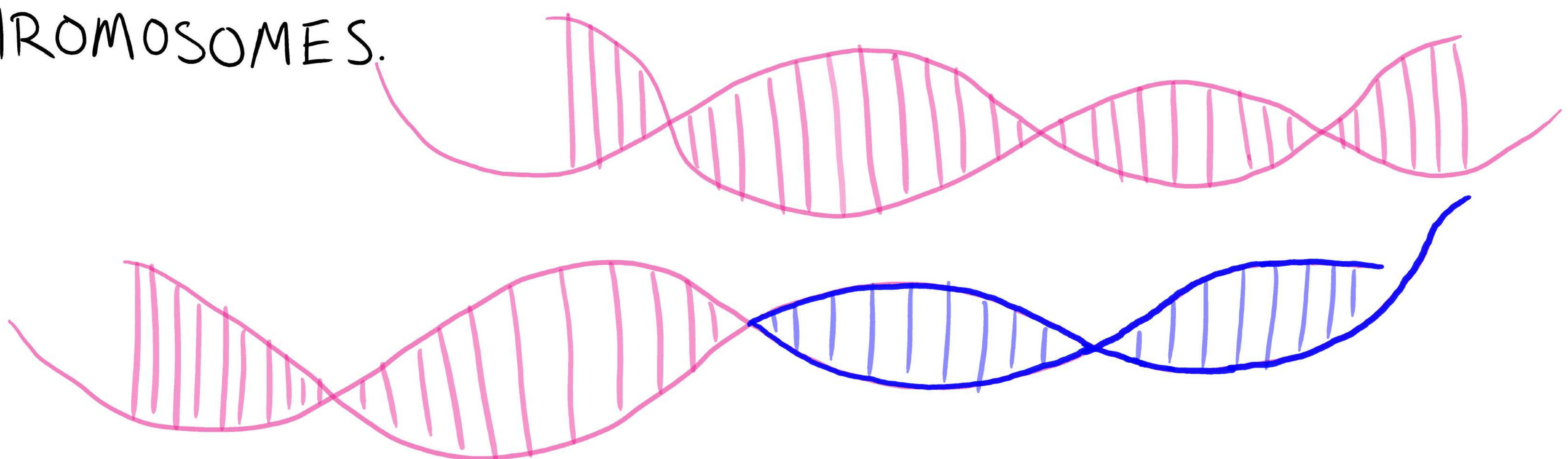
SO, RETURNING TO  
OUR **XX** EMBRYO...



SOMETIMES, CHROMOSOMES THAT ARE NEXT TO  
EACH OTHER SWAP GENES.

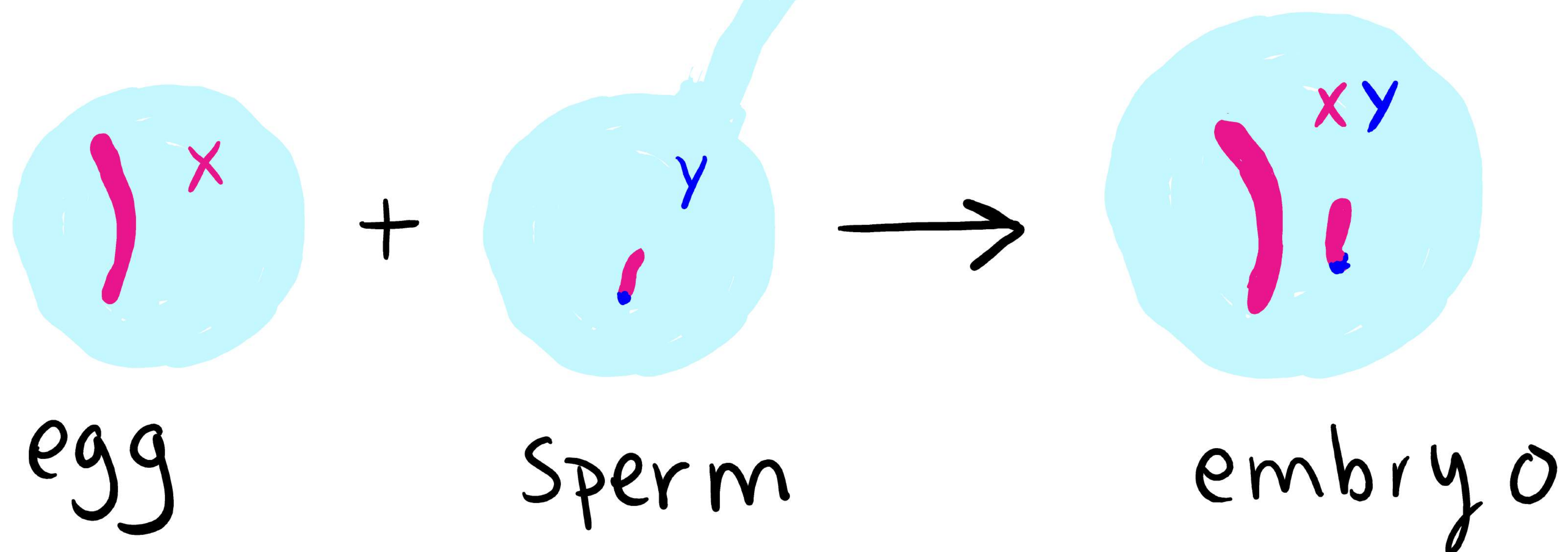


AS A RESULT, A BABY WITH TWO **X**  
CHROMOSOMES COULD HAVE SOME OR  
ALL OF THE GENES ON A TYPICAL **Y**  
CHROMOSOMES.





SIMILARLY, A BABY WITH A  $Y$  CHROMOSOME MAY DEVELOP SIMILAR TO THE AVERAGE  $XX$  GENOTYPE.



AND EVEN IF THEY HAVE "TYPICAL" VERSIONS OF BOTH CHROMOSOMES, INTOLERANCE TO CERTAIN HORMONES WILL CAUSE AN  $XY$  EMBRO TO DEVELOP A UTERUS AND VAGINA

ONCE YOU START FACTORING IN THREE AND FOUR CHROMOSOME GENOTYPES (LIKE  $XXX$  OR  $XYX$ ), THE POSSIBILITIES ARE ENDLESS!



That's why  
*any*  
 genotype  
 can produce  
*any*  
 phenotype!

	vagina	uterus	penis	testicles	ambiguous
XX	✓	✓	✓	✓	✓
XY	✓	✓	✓	✓	✓
XXY	✓	✓	✓	✓	✓
XXX	✓	✓	✓	✓	✓
XXXY	✓	✓	✓	✓	✓

NOW THAT WE'VE COVERED SOME OF THE WAYS  
 GENOTYPE DOESN'T PROVIDE A SCIENTIFICALLY RIGOROUS  
 DEFINITION FOR SEX, LET'S  
 COVER WHY PHENOTYPE CAN  
 BE JUST AS VAST,  
 MURKY, AND COMPLICATED.

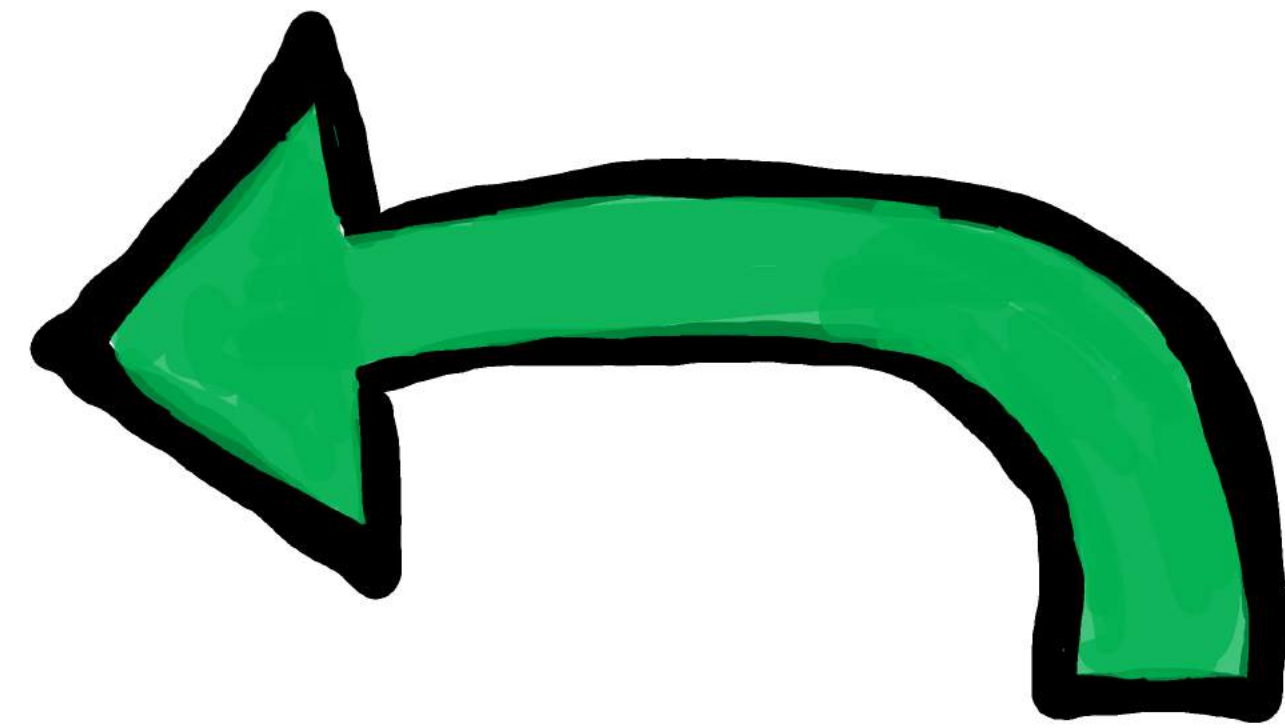




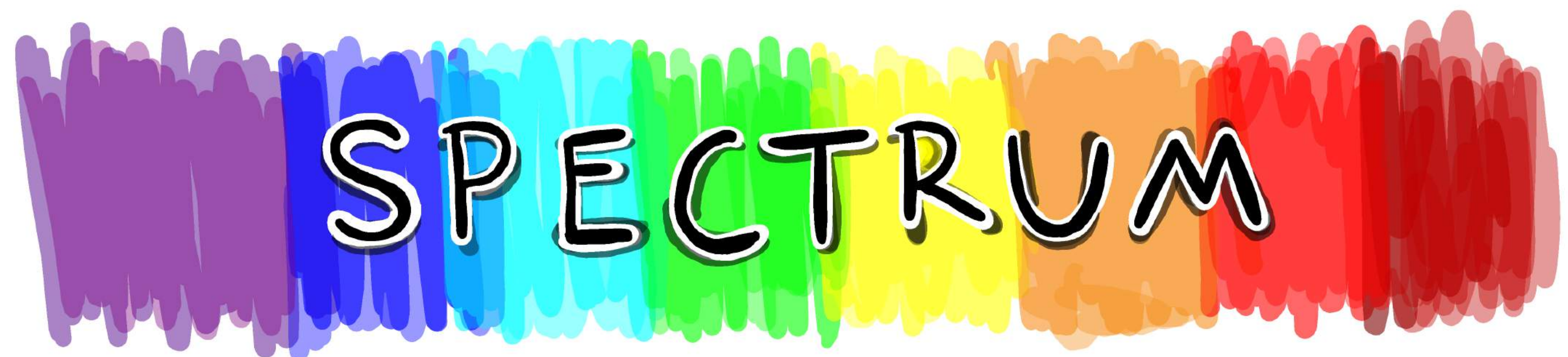
IF HUMANS ONLY HAD 2 SEXES, WE COULD PROBABLY DETERMINE SEX BY PHENOTYPE. EVEN "IRREGULAR" (AKA LESS COMMON) GENITALS WOULD, MOST LIKELY BE IDENTIFIABLE AS ONE OR THE OTHER.



WELL, WHAT DOES IT LOOK LIKE?



THIS DOESN'T WORK BECAUSE HUMAN SEX ORGANS DEVELOP ALONG A



AND NOT A **BINARY** AS WE OFTEN ASSUME.

AS A RESULT, AS MANY AS

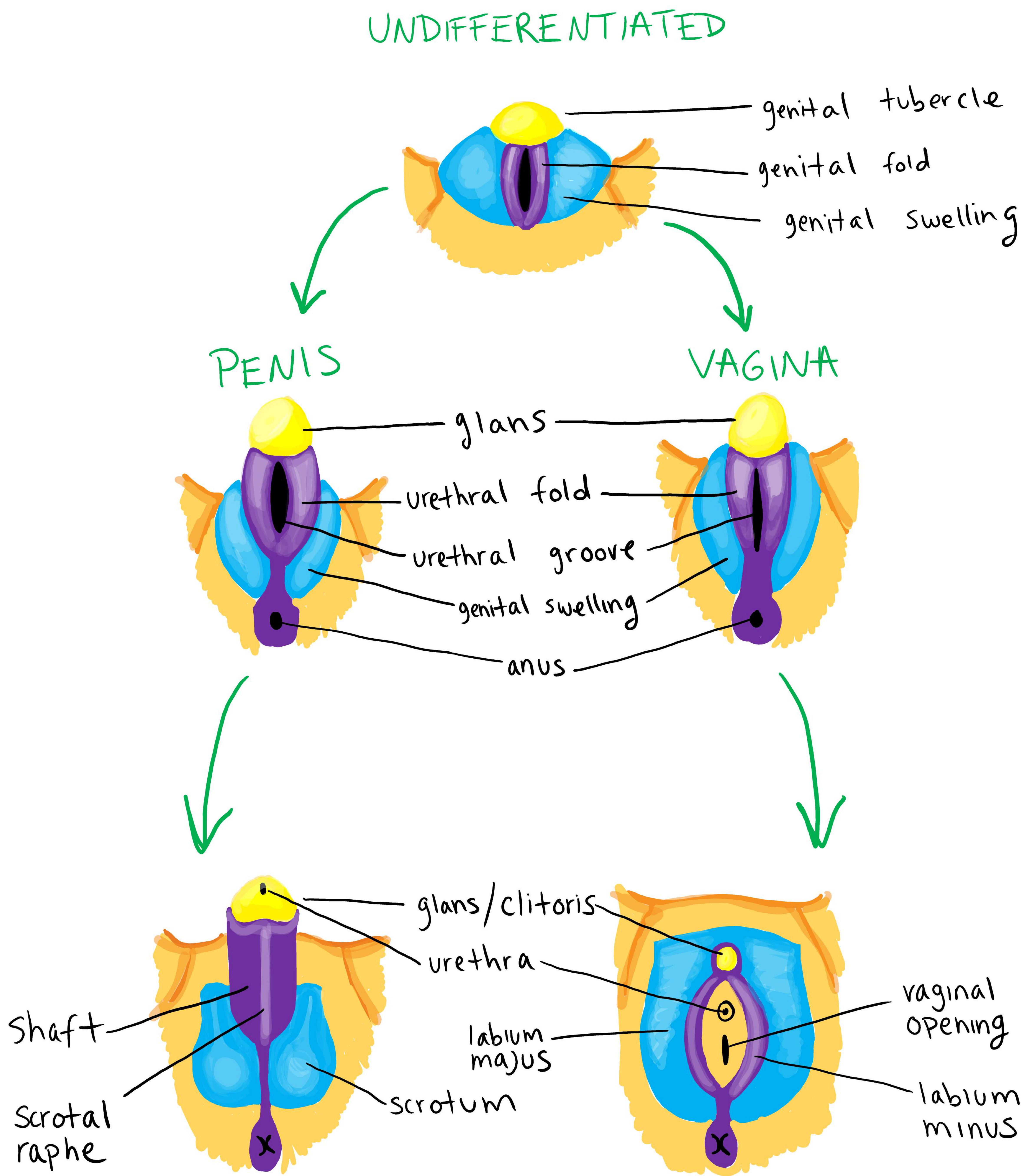


PEOPLE HAVE BODIES THAT DON'T FIT INTO A 2 SEX BINARY

<sup>2</sup>Intersex Society of America, 2016



NEARLY EVERY EMBRYO STARTS WITH THE SAME PRE-GENITAL MOUND OF CELLS. THE PRESENCE OR ABSENCE OF CERTAIN HORMONES CAUSE THE CELLS TO DIFFERENTIATE INTO A PENIS OR VAGINA





IN OTHER WORDS, DESPITE LOOKING OUTWARDLY DISTINCT,  
THE PENIS AND VAGINA ARE VERY SIMILAR ORGANS -  
THEY ARE JUST SHAPED DIFFERENTLY.

SOME FOLKS DEVELOP ALONG A DIFFERENT PATH,  
OR STOP AT VARIOUS STAGES IN THE PROCESS.



AND EXTERNAL GENITALS DON'T  
NECESSARILY PREDICT INTERNAL GENITALS

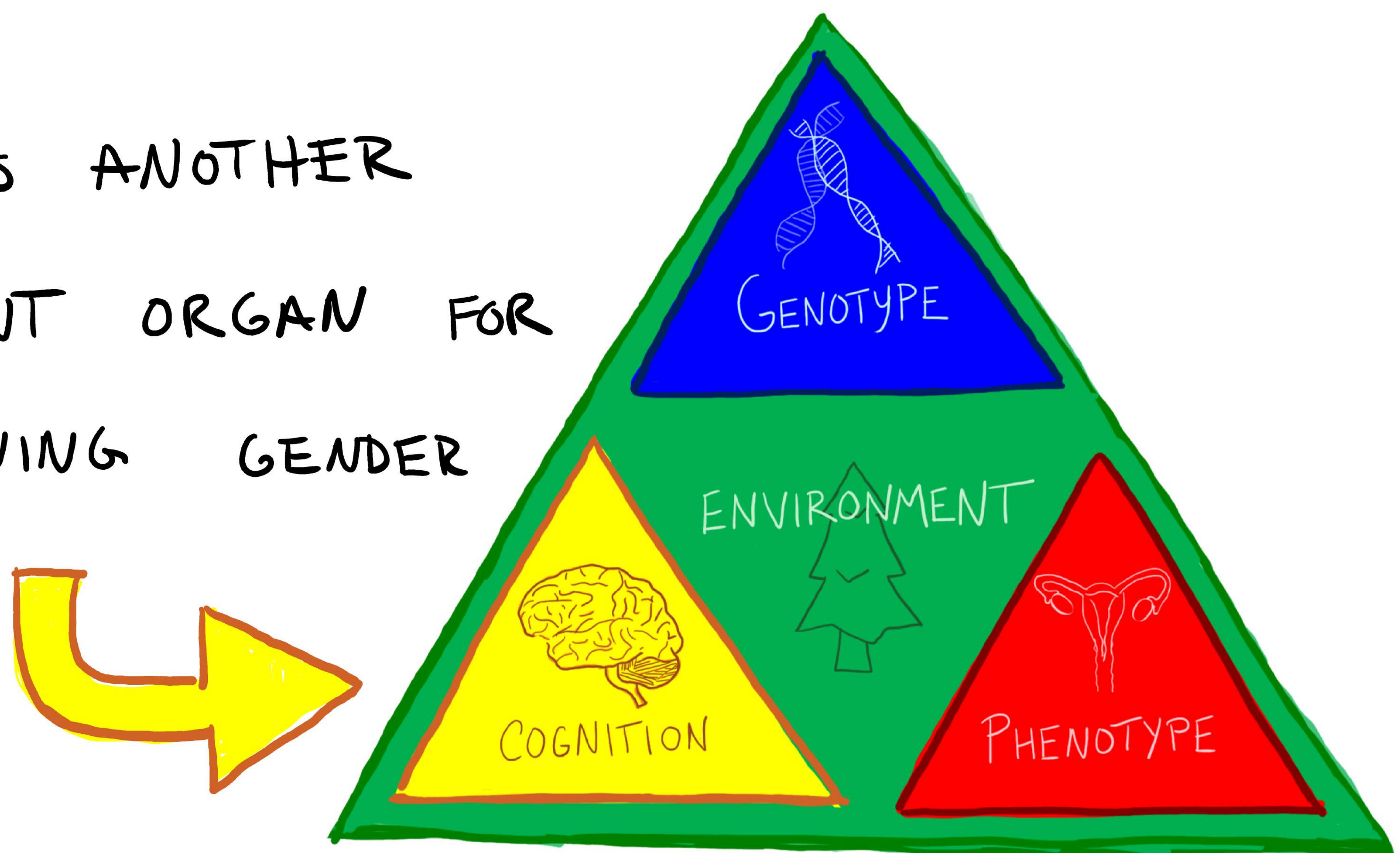
FOR EXAMPLE - SOME WITH XY OR XXY AND PARTIAL  
ANDROGEN (A HORMONE) INSENSITIVITY HAVE A UTERUS,  
ONE OVARY, A SCROTUM, A PENIS, AND ONE TESTICLE.

(THESE FOLKS MAY NEED A VAGINAL OPENING  
CREATED SURGICALLY TO ALLOW MENSTRUATION.)

*The point is, nothing about gender  
is guaranteed by biology.*



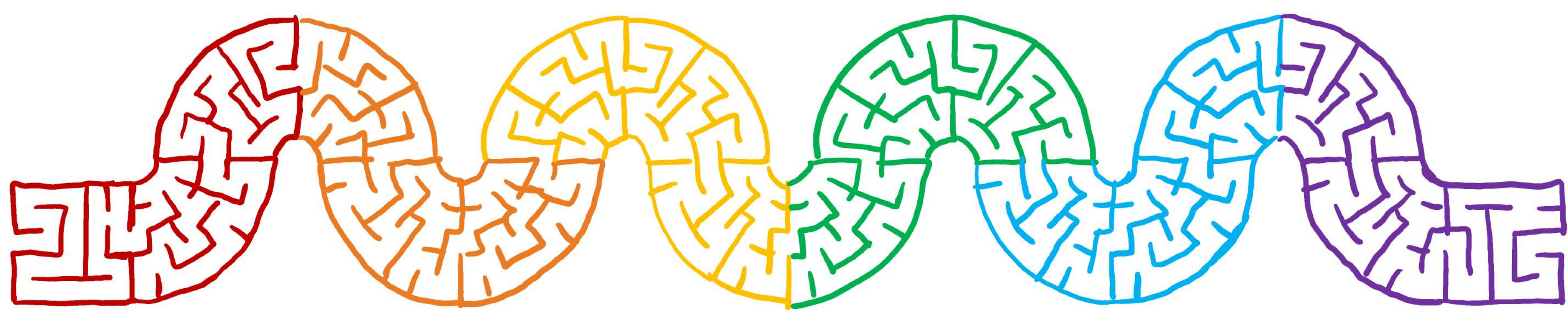
THERE'S ANOTHER  
IMPORTANT ORGAN FOR  
DETERMINING GENDER



## THE BRAIN!

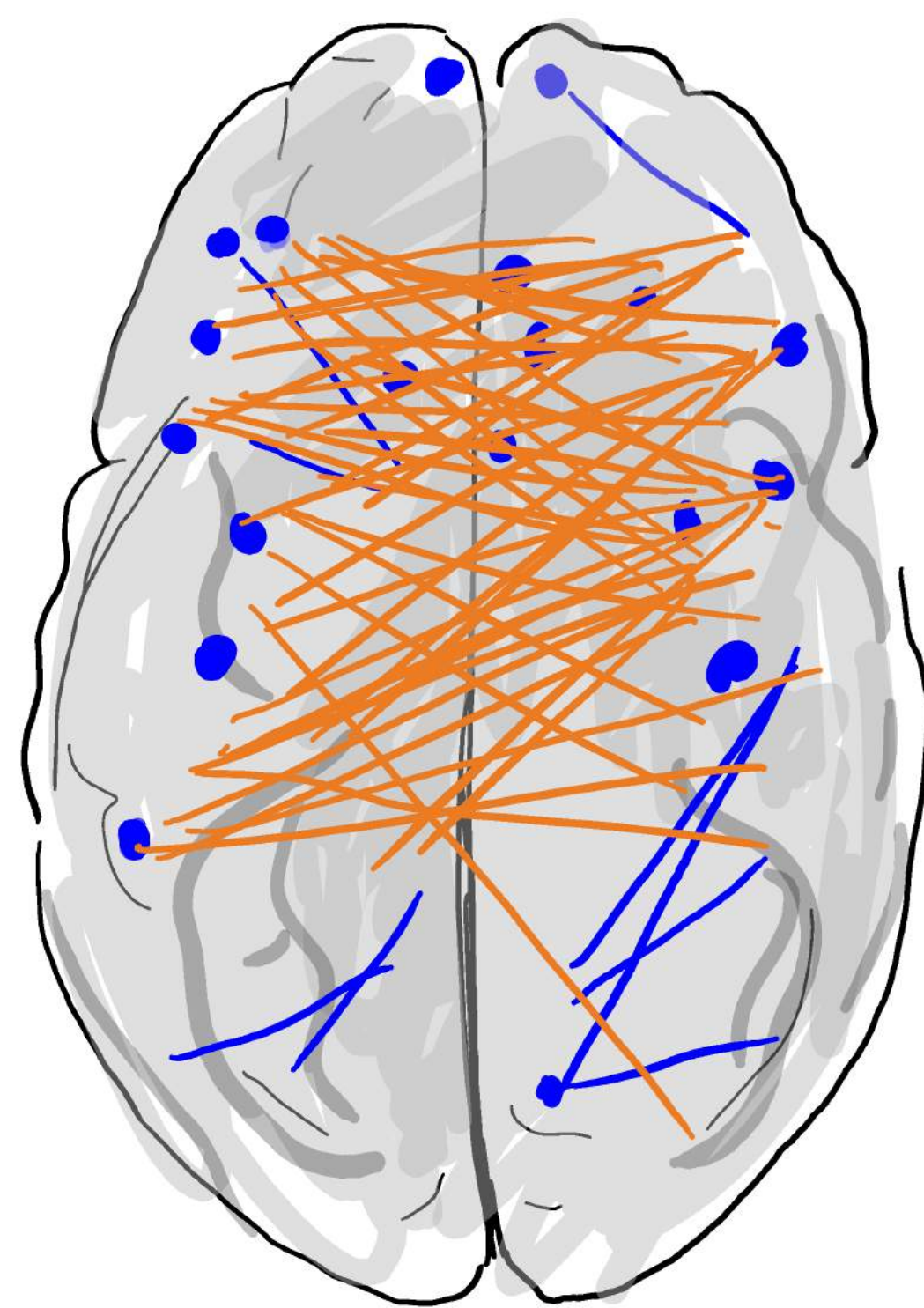
THIS IS WHERE THE LACK OF STABLE  
SEXES REALLY BECOMES APPARENT!

THERE IS QUITE A BIT WE STILL DON'T  
UNDERSTAND ABOUT THE BRAIN, BUT WE DO  
KNOW IT IS INVOLVED IN GENDER. THIS NEXT  
BIT IS A LITTLE TECHNICAL, BUT WE GOT THIS!

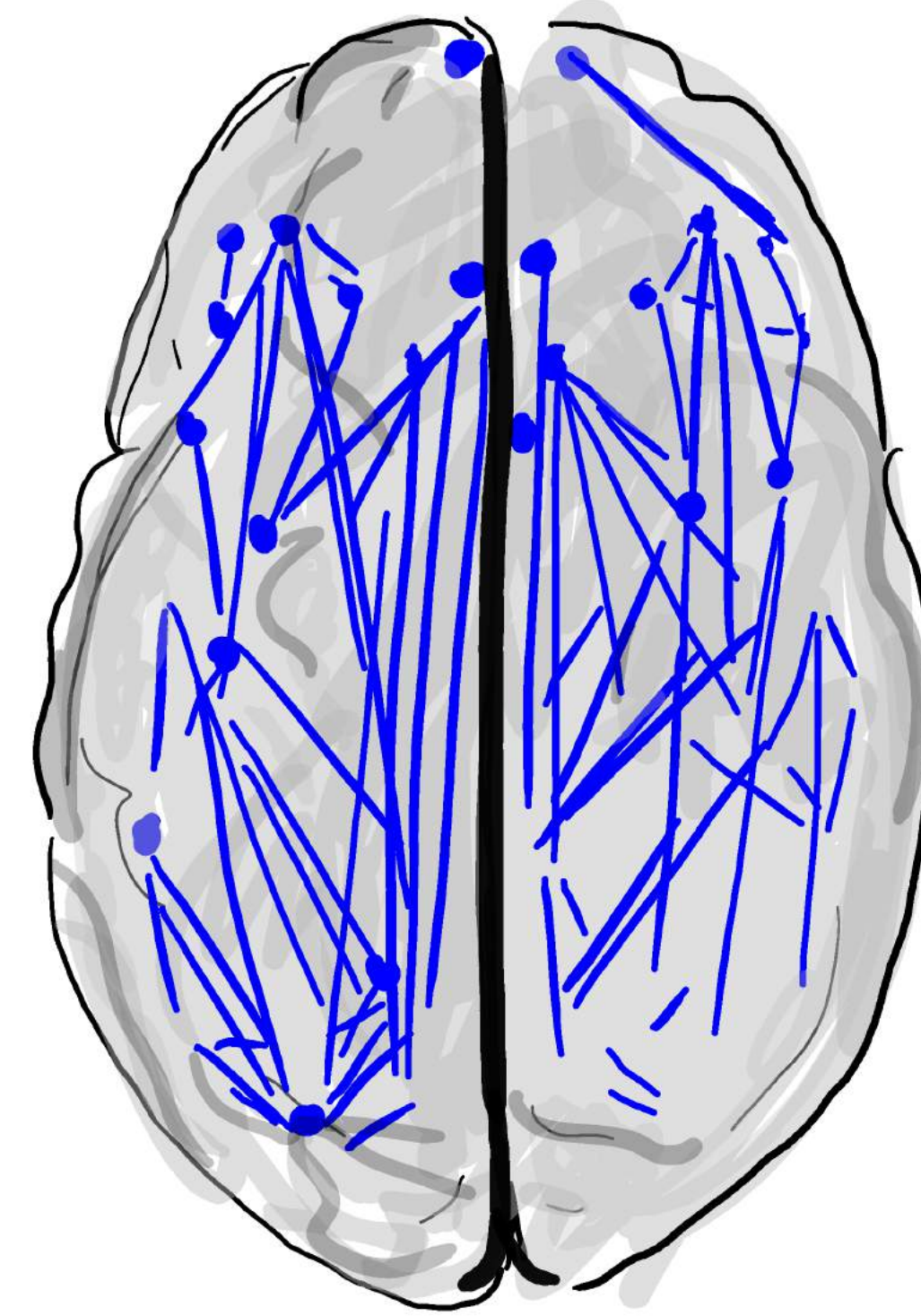




A 2014 STUDY<sup>3</sup> PUBLISHED IN THE PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCE EXAMINED THE BRAINS OF 1,000 PEOPLE AGED 8-22.



FEMALE  
BRAIN



MALE  
BRAIN

THOUGH THERE WERE **NO** DIFFERENCES BETWEEN THE BRAINS OF CHILDREN, AROUND AGE 14, WOMEN BEGIN DEVELOPING **CONNECTIONS BETWEEN HEMISPHERES OF THE BRAIN, SUGGESTING LOGIC AND INTUITION WORKING TOGETHER**, WHEREAS MEN DEVELOPED **CONNECTIONS WITHIN THE SAME SIDE, SUGGESTING THOSE AREAS FUNCTION SEPARATELY**.

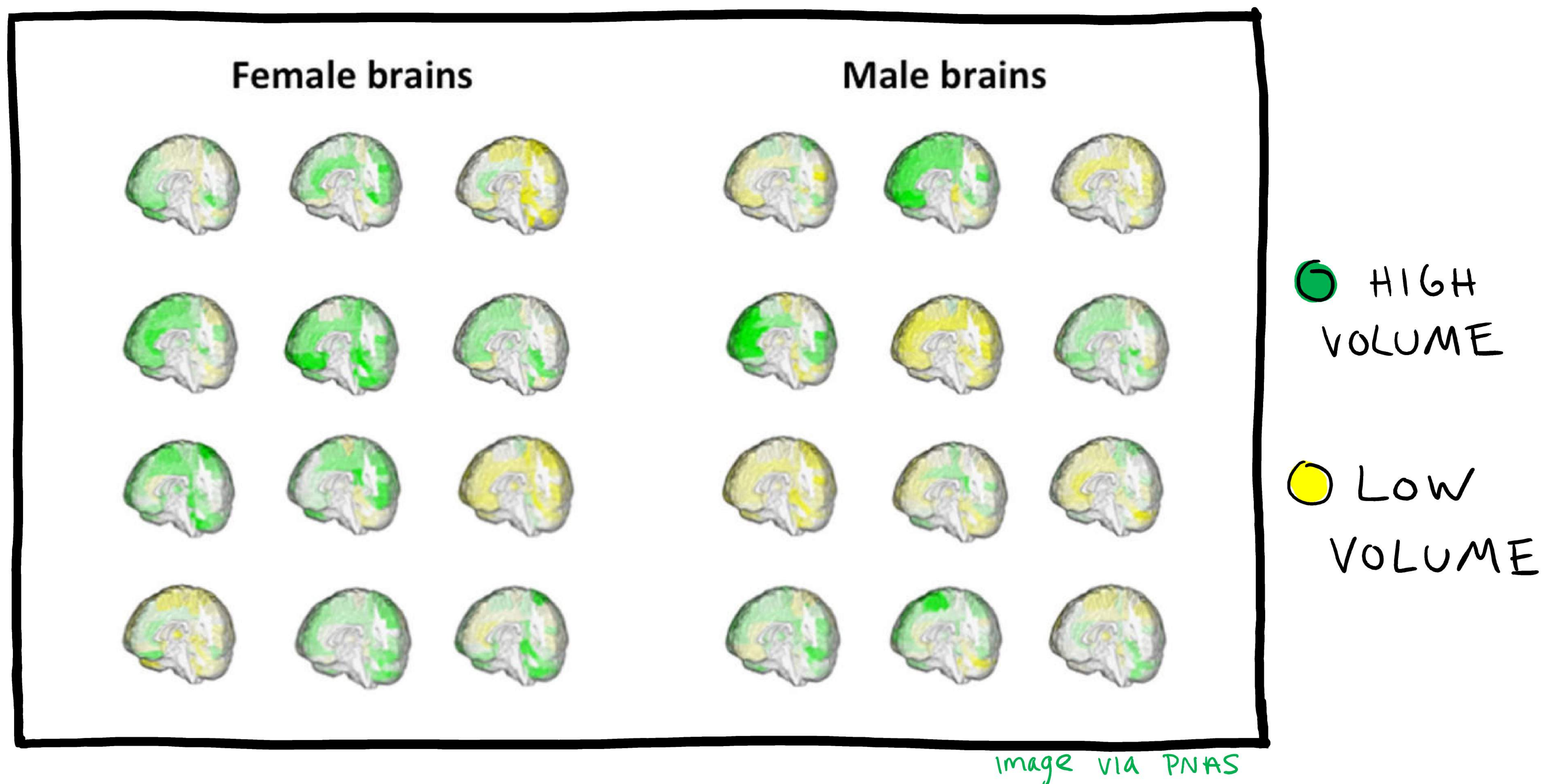
BECAUSE THIS HAPPENS IN ADOLESCENCE, IT'S UNCLEAR IF IT IS LEARNED OR INNATE

<sup>3</sup>Ingathalikar, Madhura, et al. "Sex differences in the structural connectome of the human brain." Proceedings of the National Academy of Science 111.2 (2014): 823-828.



HOWEVER, A 2015<sup>4</sup> STUDY PUBLISHED IN THE SAME JOURNAL SHOWED THAT THOSE STRUCTURAL DIFFERENCES DIDN'T ESTABLISH A GENERALIZABLE FEMALE/MALE BRAIN.

SCANS OF BRAIN VOLUME FOUND ONLY  
6% OF BRAINS COULD BE SEPARATED INTO MALE/FEMALE.



THE RESEARCHERS THEN MEASURED BRAIN CONNECTIVITY (SIMILAR TO THE 2013 STUDY) AND GREY MATTER IN THE OUTER LAYER OF THE BRAIN.

### KEY FINDING:

OF 4,860 PARTICIPANTS, ONLY 0.1% WERE CLEARLY MALE/FEMALE, WHILE 70% HAD ELEMENTS OF BOTH.

<sup>4</sup>Joel, Daphna, et al. "Sex beyond the genitalia: The human brain mosaic." Proceedings of the National Academy of Sciences 112.50(2015): 15468-15473

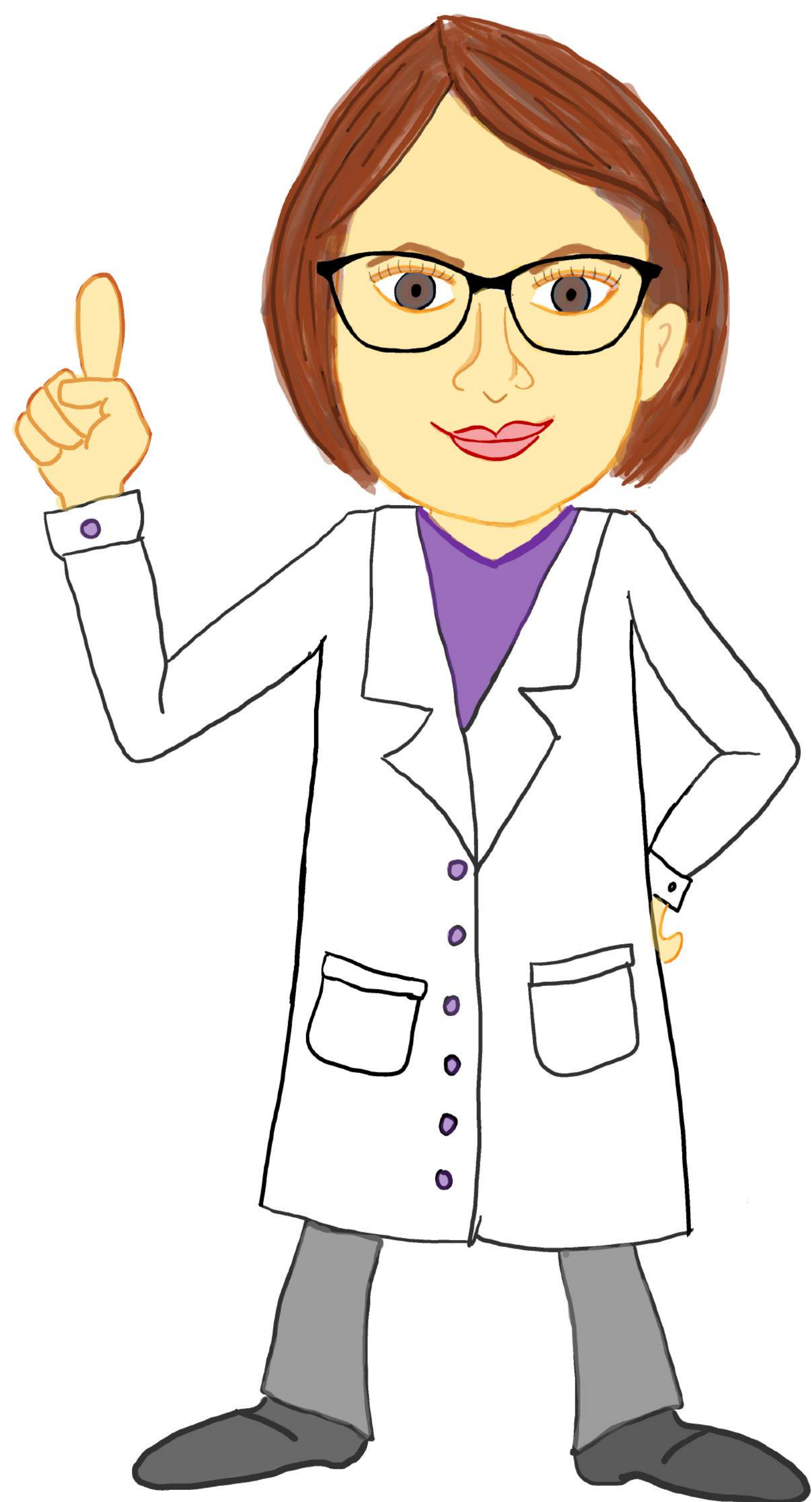


# THIS STUDY CONCLUDED...

"Although there are sex/gender differences in brain structure, brains do not fall into two classes, one typical of males and the other typical of females."

AND...

"Each brain is a unique mosaic of features, some of which may be more common in females compared with males, others may be more common in males compared with females, and still others may be common in both females and males."



But wait, here's  
where it  
**really**  
gets interesting!



EVEN THOUGH THERE IS SUBSTANTIAL VARIANCE  
AMONG INDIVIDUAL BRAINS, THERE ARE SOME  
**FASCINATING** FINDINGS AT THE LEVEL OF  
AVERAGES AND AGGREGATE DATA

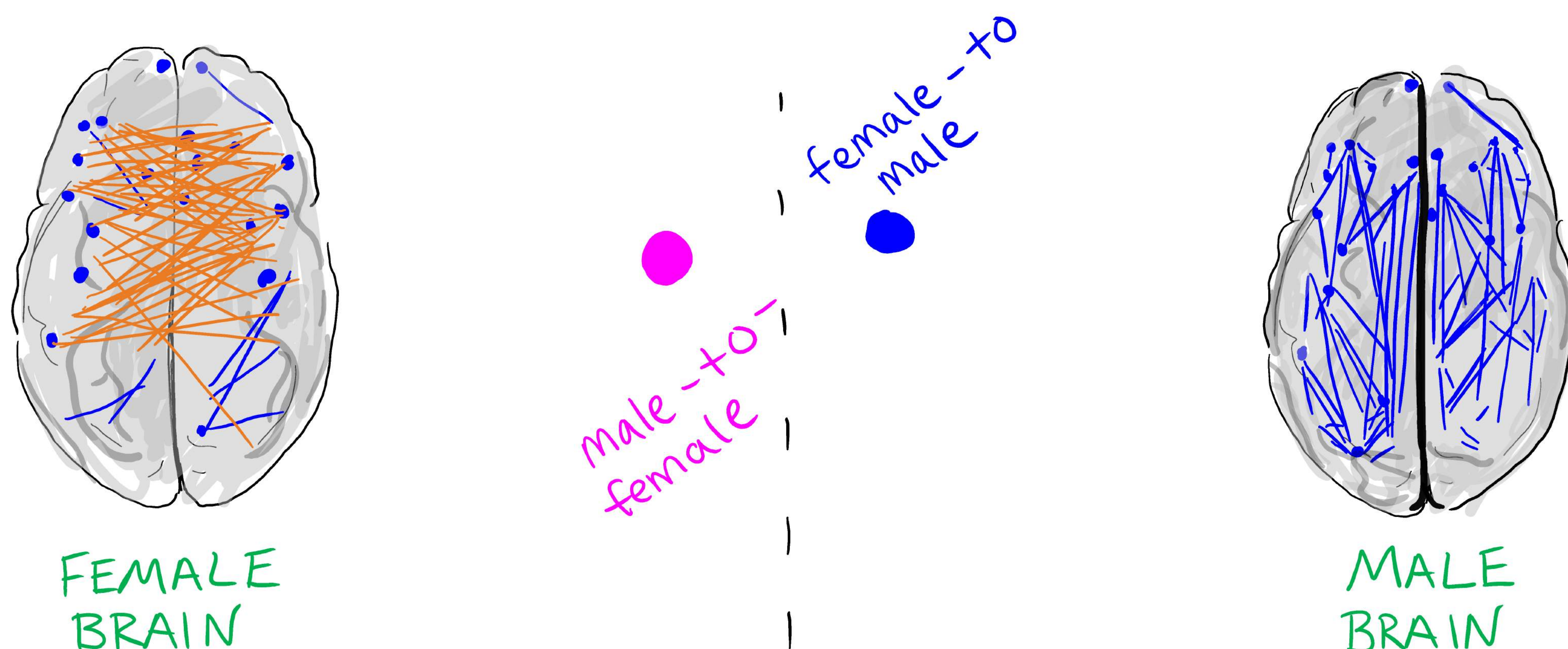
A 2011 STUDY<sup>5</sup>, PUBLISHED IN THE JOURNAL  
OF PSYCHIATRIC RESEARCH, ANALYZED THE BRAINS OF  
TRANSGENDER PEOPLE BEFORE AND AFTER HORMONE  
REPLACEMENT THERAPY (HRT).

---

### KEY FINDING:

BOTH BEFORE AND AFTER HRT, THE BRAINS OF  
TRANSGENDER PEOPLE HAD SIMILAR STRUCTURES  
TO THOSE CORRELATED WITH THEIR GENDER IDENTITY.

USING THE EARLIER EXAMPLE OF TWO BRAINS ON  
OPPOSITE EXTREMES:



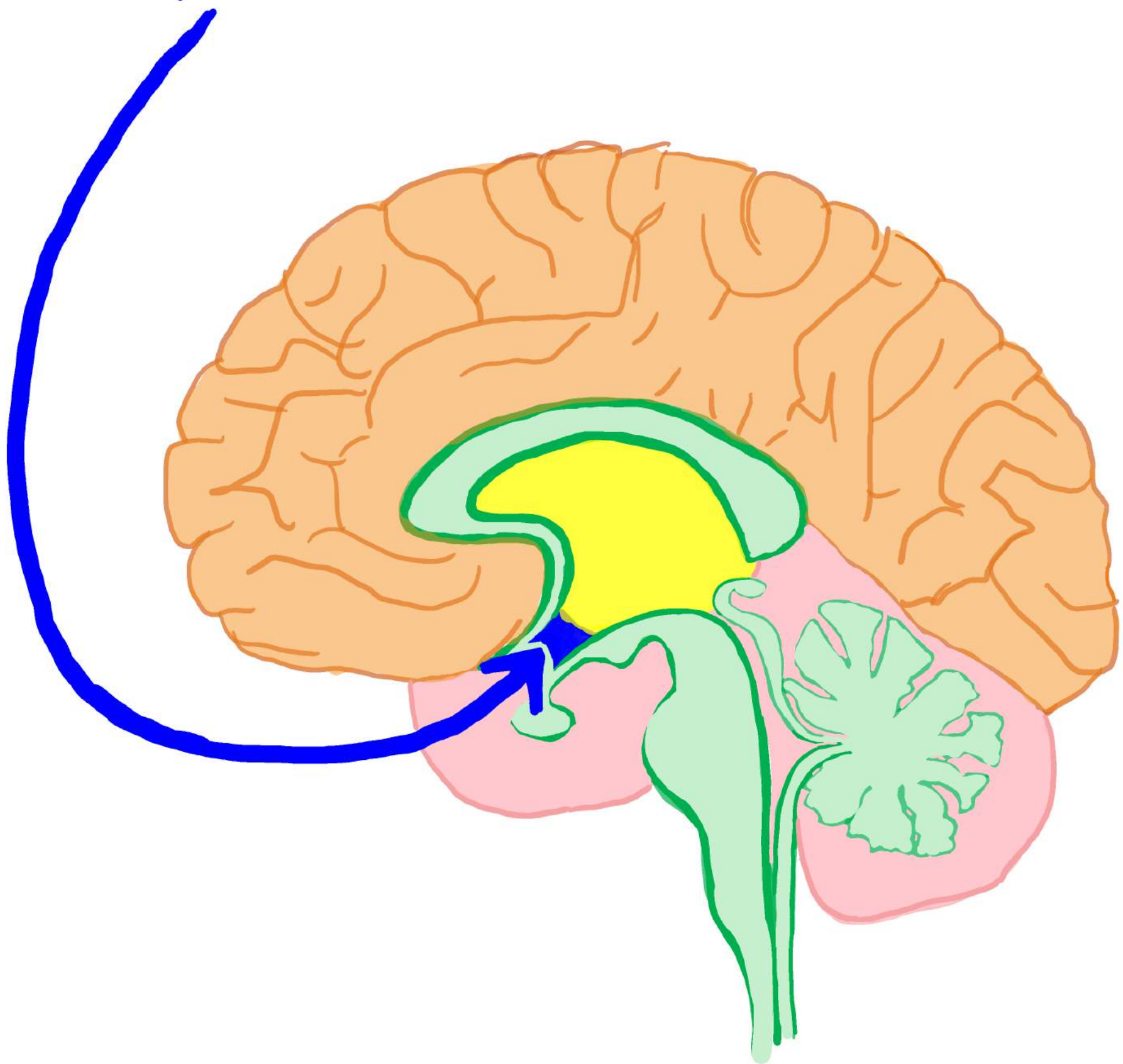
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<sup>5</sup> Rametti, G., Carrillo, B., Gómez-Gil, E., Junque, C., Segovia, S., Gómez, A., & Guillamón, A., (2011). White matter microstructure in female to male transsexuals before cross-sex hormonal treatment: A diffusion tensor imaging study. *Journal of psychiatric research*, 45(2), 199-204.



THOUGH THERE IS NO CONCLUSIVE WAY TO KNOW IF THIS IS INNATE, LEARNED, OR ENVIRONMENTAL, THERE ARE SOME CLUES.

A 2014 EXPERIMENT<sup>6</sup> PUBLISHED IN FRONTIERS OF ENDOCRINOLOGY ANALYZED TRANSGENDER CHILDREN'S RESPONSE TO ANDROSTADIENONE, A PHEROMONE-LIKE CHEMICAL THAT CAUSES DIFFERENT RESPONSES IN THE **HYPOTHALAMUS** OF MEN VS. WOMEN WHEN SMELLED.



**KEY FINDING:**

IN ADOLESCENT CHILDREN, RESPONSES WERE CONSISTENT WITH GENDER IDENTITY, NOT SEX ASSIGNED AT BIRTH.

IT IS UNLIKELY THIS WOULD BE LEARNED OR ENVIRONMENTAL, SUGGESTING IT IS INNATE.



<sup>6</sup> Burke, Sarah M., et al. "Hypothalamic response to the chemo-signal androstadienone in gender dysphoric children and adolescents." *Frontiers in endocrinology* 5 (2014).





## MAJOR KEY FINDING:

Overall, transgender brains are unique—  
unlike cisgender male or female brains<sup>5</sup>

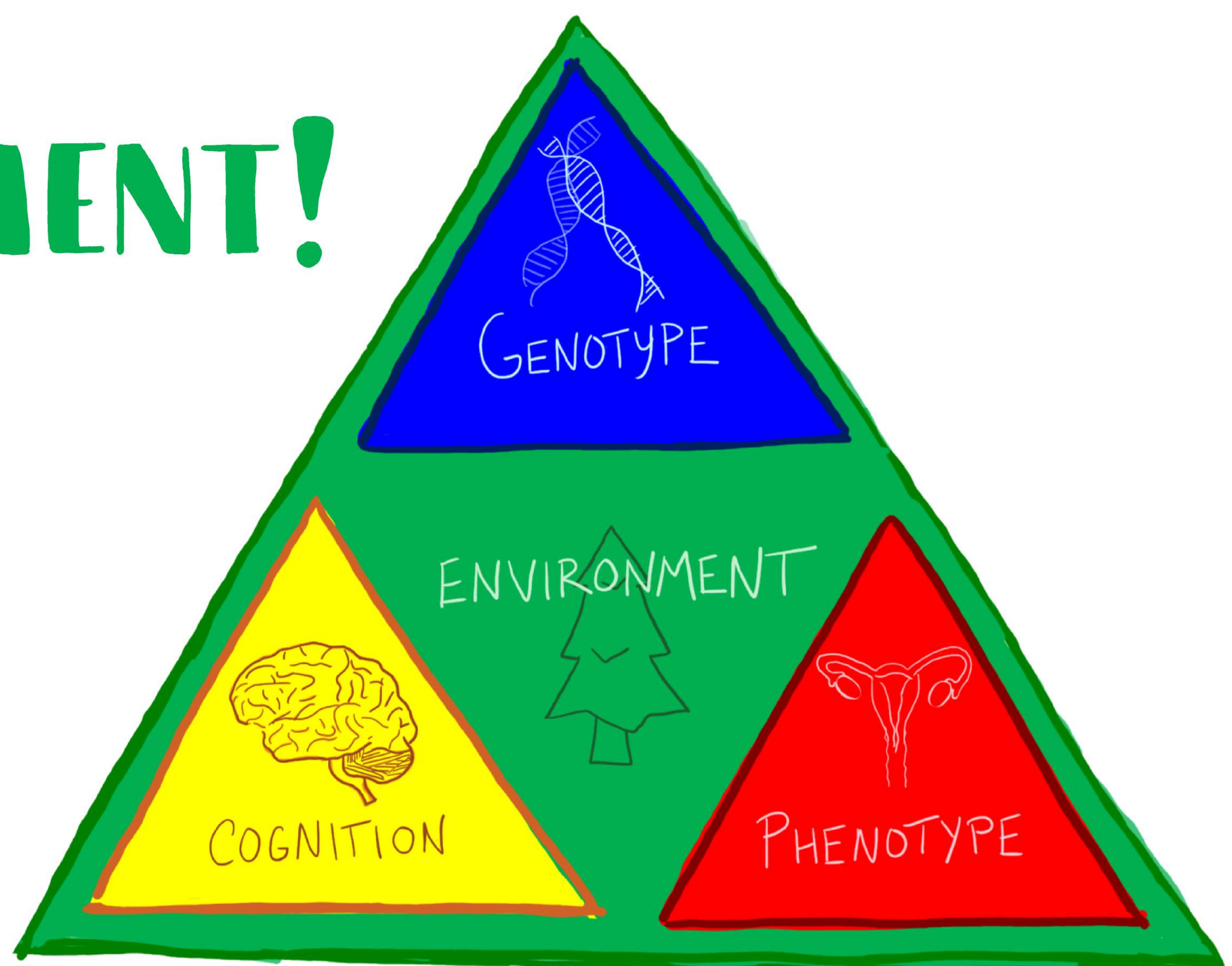
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(cisgender = identifies with gender assigned at birth)

WE'VE COVERED THREE FACTORS THAT  
INFORM GENDER — GENOTYPE,  
PHENOTYPE, AND COGNITION

THERE'S JUST ONE THING  
LEFT TO COVER:

# THE ENVIRONMENT!



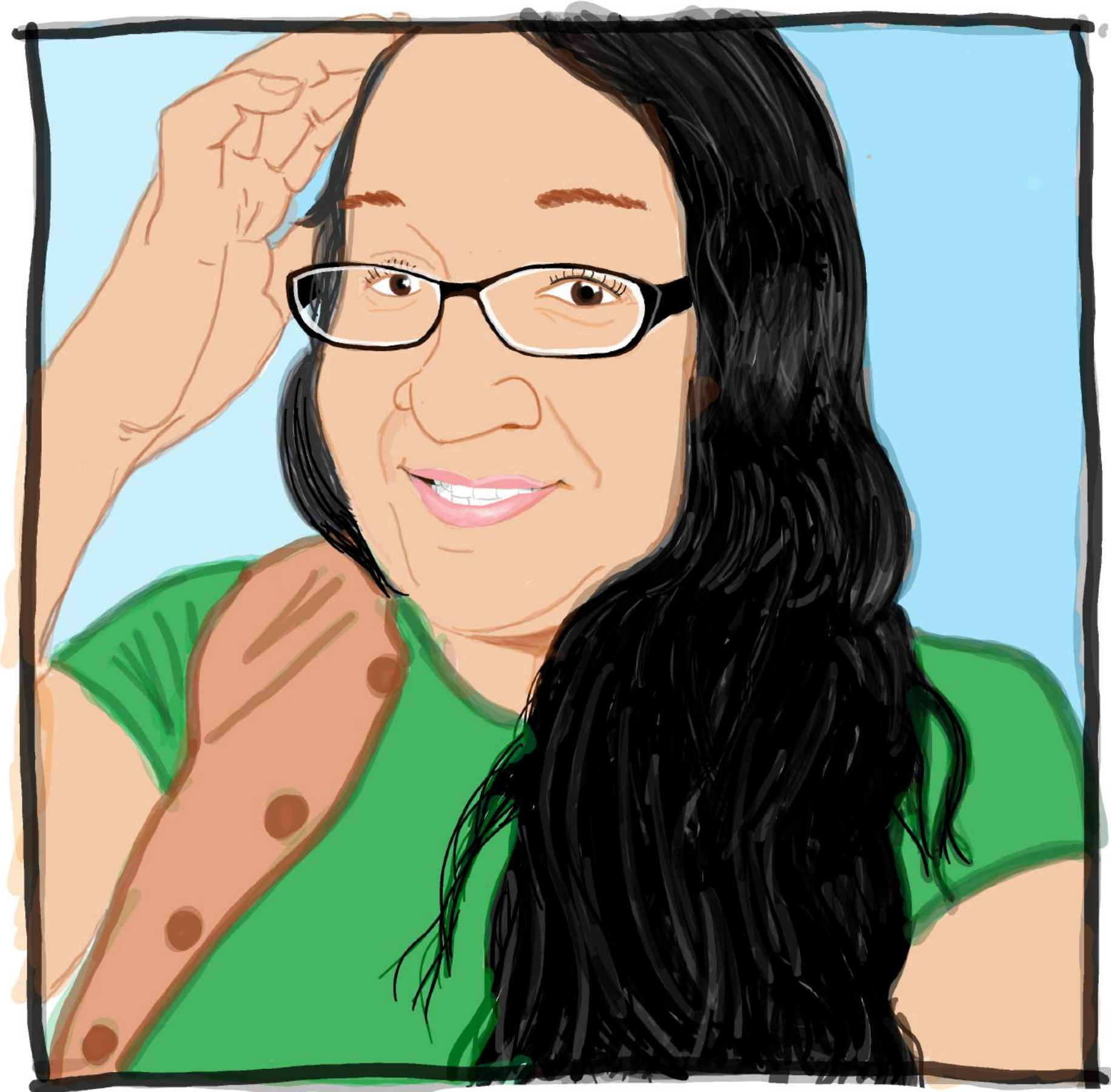


THE ENVIRONMENT IMPACTS GENDER IN A FEW WAYS, THREE OF WHICH I'LL EXPLAIN:

## 1) CULTURE

DIFFERENT CULTURES BREAK UP THE SPECTRUM OF GENDER IN OTHER WAYS:

NATIVE AMERICAN NATIONS RECOGNIZE BETWEEN 3 AND 5 GENDERS, SUCH AS TWO-SPIRIT



JAMIE LEE WOUNDED ARROW



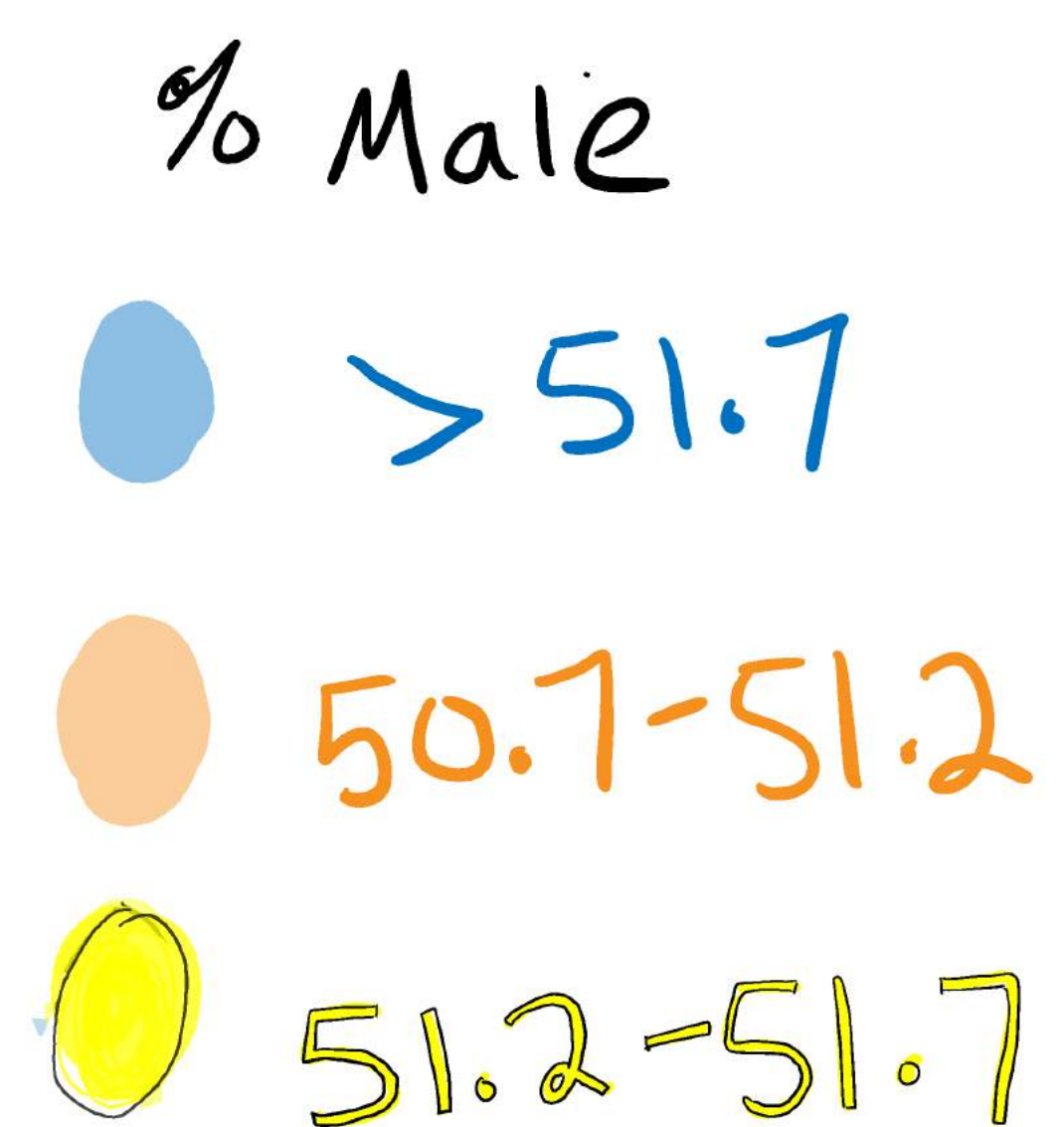
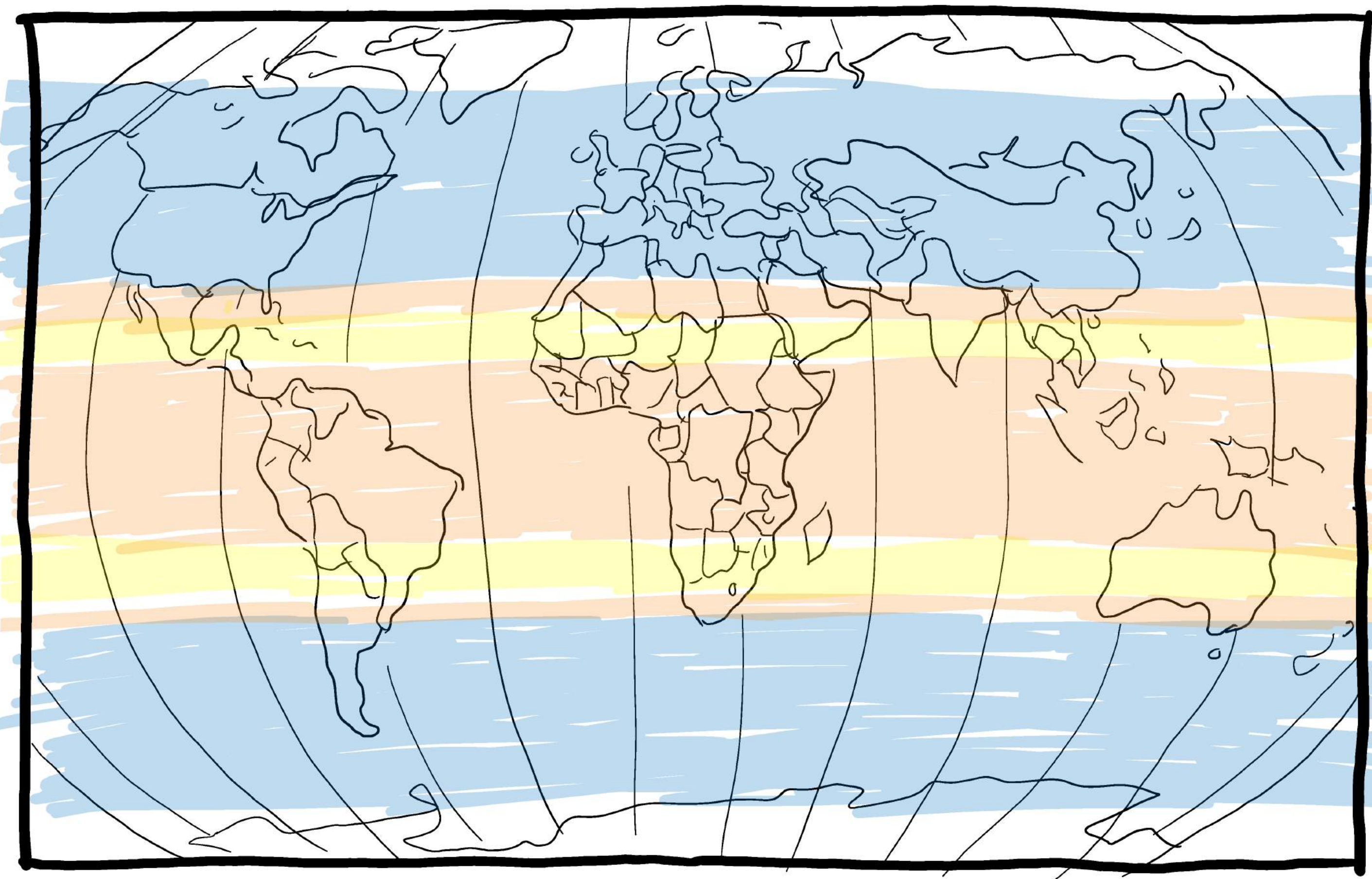
ITALY (PARTICULARLY NAPOLI) HAS LONG RECOGNIZED FEMMINIELLI (SINGULAR: FEMMINIELLO), WHICH CAN REFER TO GAY MEN OR TRANSGENDER WOMEN, AND ARE BELIEVED TO BRING GOOD LUCK.

PBS HAS A MAP OF GENDER DIVERSITY AT [PBS.ORG/INDEPENDENTLENS/CONTENT/TWO-SPIRIT\\_MAPS.html](https://www.pbs.org/independentlens/content/two-spirit-maps.html) FOR THOSE LOOKING TO EXPLORE MORE!



## 2) GEOGRAPHY

A 2009 STUDY<sup>7</sup> PROVIDED THE FIRST GLOBAL LOOK AT BIRTH RATES, AND FOUND THAT LATITUDE INFLUENCES HUMAN SEX DETERMINATION.



AREAS WITH LONG, DARK WINTERS (SHADED IN BLUE) PRODUCE MORE MALES. THE TROPICS PRODUCE SIGNIFICANTLY LESS MALES.

This is thought to be due to melatonin, a chemical that regulates both sleep and the production of hormones associated with female development.



### 3) GENETIC ISOLATION

THE GENETIC ELEMENTS OF SEX VARY GEOGRAPHICALLY, AND THE MORE ISOLATED A COMMUNITY IS, THE FASTER A GENE CAN SPREAD THROUGH A POPULATION.

IN SALINAS, DOMINICAN REPUBLIC, THERE IS A VERY HIGH PREVALENCE OF GUEVEDOCES, OR PEOPLE BORN WITH A VAGINA, BUT WHO GROW A PENIS AT AGE 12.

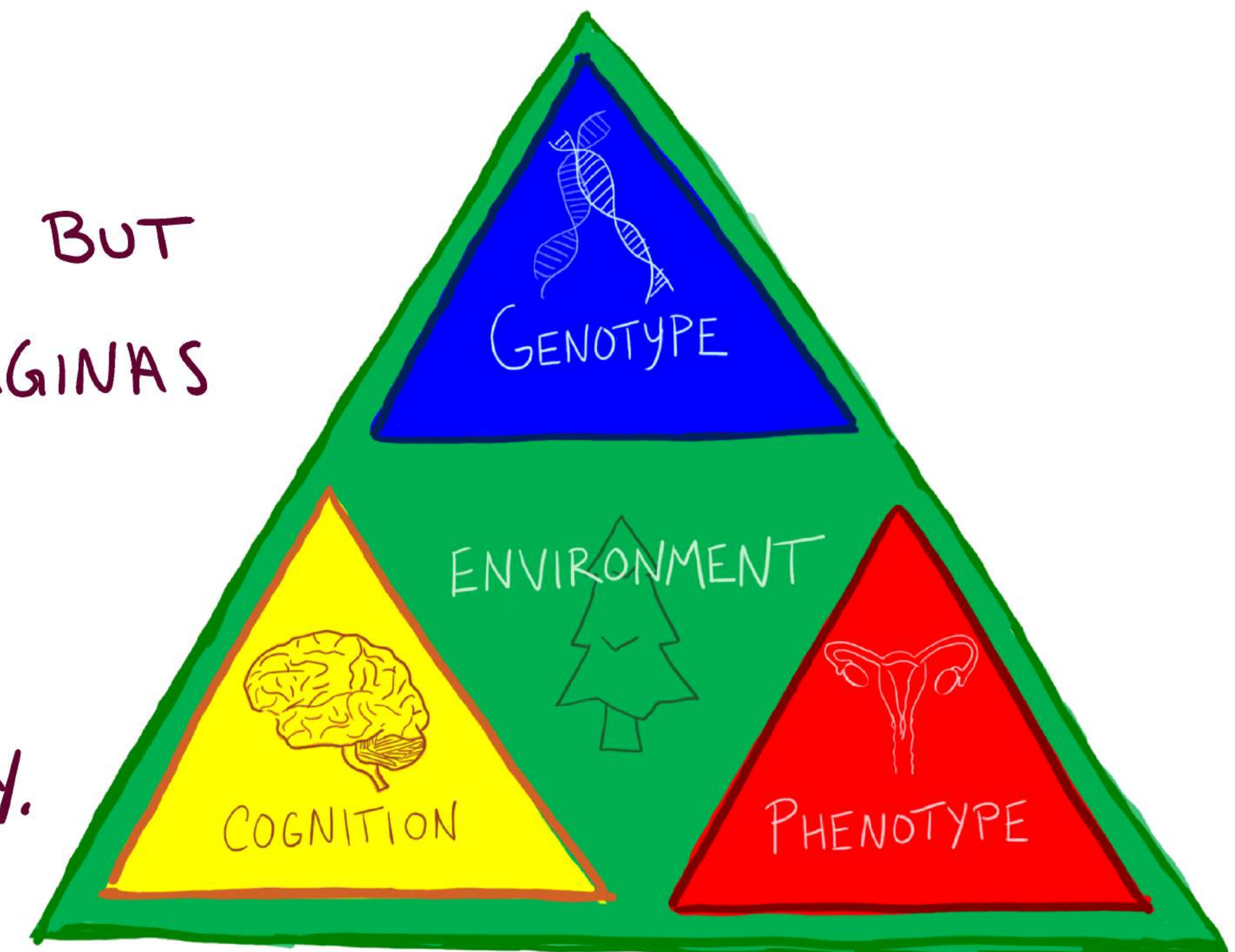


(ESSENTIALLY, THEY DON'T RESPOND TO ANDROGEN HORMONES IN THE WOMB, AND SO ARE BORN WITH AN APPARENT VAGINA OR UNDIFFERENTIATED GENITALS, WHICH DEVELOP INTO A PENIS AND TESTICLES WITH THE HORMONE RUSH OF PUBERTY.)



SO, WHAT DO WE TAKE AWAY FROM ALL THIS INFORMATION? SEX IS COMPLICATED IN EVERY SPECIES, AND HUMANS ARE NO EXCEPTION.

YES, THERE ARE EGGS AND SPERM, BUT SOMETIMES PENISES MENSTRUATE, AND VAGINAS COME WITH TESTICLES, AND 38.7 MILLION PEOPLE IN THE U.S. DON'T PRODUCE EITHER OR STRUGGLE WITH INFERTILITY.



We, as humans, put language to our bodies so that we could communicate ourselves to others. Whether it is a child or old friend, or someone using language for themselves that you didn't expect, the best thing we can do is listen.



Listen, because they are telling you who they are, and they know themselves better than you do.

and loving someone means as they are, not as you think they should be.



Because sex is not a chromosome.

*It's not a reproductive organ.  
Or what "down there" looks like when you're born.*

Sex is not a pattern on a brain scan.

*And if you were born in a different time  
or place, it might change.*

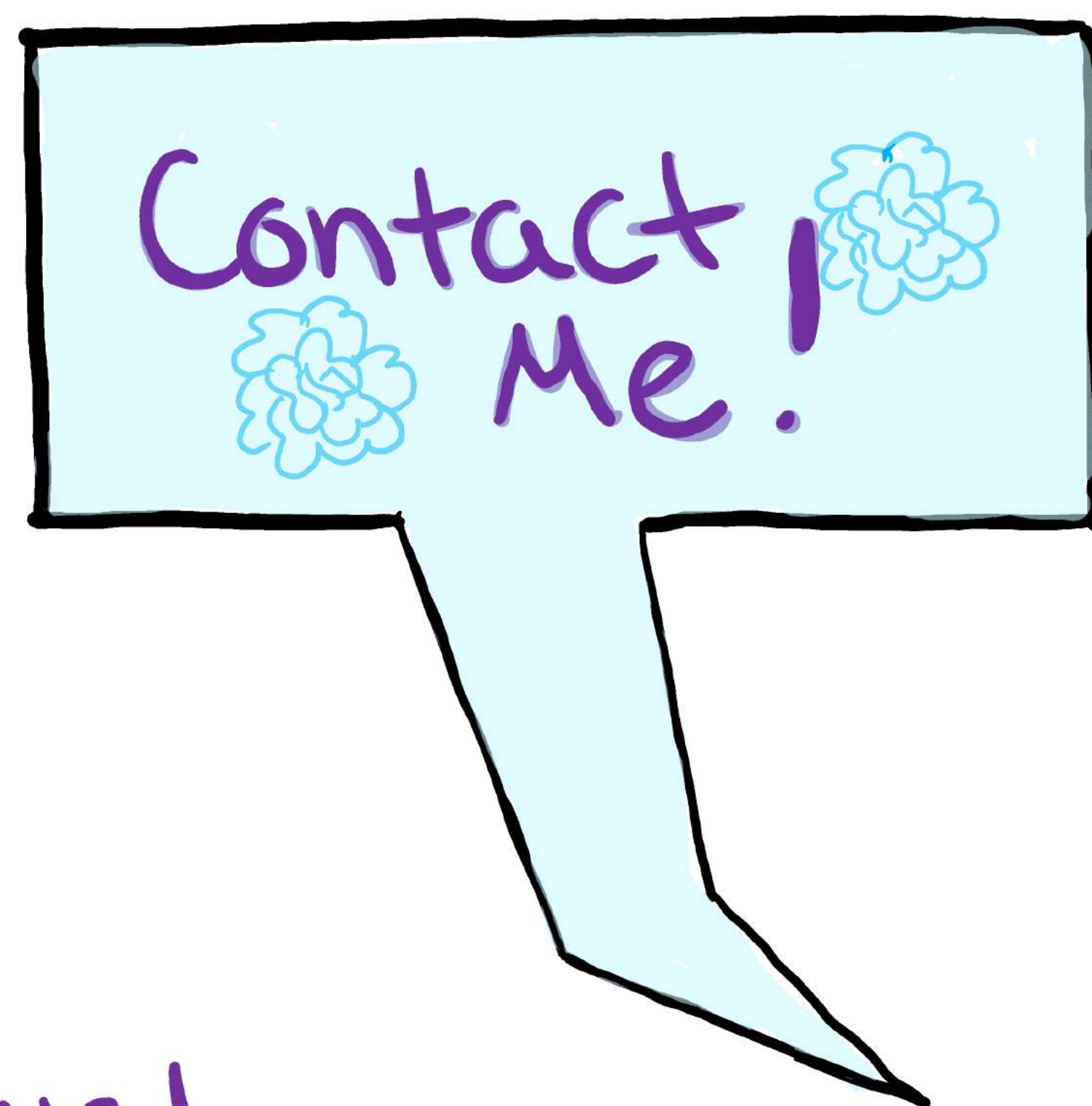
Sex is all of these things, interpreted  
through heuristics that aren't precise.

**SCIENCE CAN'T DEFINE YOUR SEX (OR GENDER).**

**ONLY YOU CAN DO THAT.**



# QUESTIONS, COMMENTS, OR IDEAS FOR FUTURE ILLUSTRATIONS?



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