Reinventing Sex: The Construction of Realistic Definitions of Sex & Gender

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Turn outward the woman's, turn inward, so to speak, and fold double the man's, and you will find the woman in both in every respect.

Galen of Pergamum (c. 130–200)[1]

In *Making Sex*, Laqueur (1990) argues that sometime in the late 18th century, sex, as we know it, was invented. At this time definitions and descriptions began magnifying sexual differences as male and female became opposites and the essence of one's biological self. This Victorian notion was far from the portrayal of one flesh given by Galen and others as early as the second century. Today, the so-called biology of sex differences is embedded in cultural, political and social programs. High school and undergraduate survey biology courses quietly reinforce these images through dichotomous discussions of male and female chromosomes, hormones and reproductive organs. As educators, we must review recent reproductive research and construct a more appropriate understanding of sex. This article begins the process of reinventing sex by presenting biological evidence supporting a more unified view of female and male.

Biology curriculums rarely mention the historical setting in which scientific advances occur. Yet students should recognize that science is practiced within a social and political context, and in spite of its perceived objectivity, science is rarely immune to this influence. What questions are asked, how they are asked, and what observations are "seen" may be affected by the politics, economics or culture of the time. This is not to imply that gathered data is a construction rather than a reality, but instead to emphasize that what is unseen, what is unreported, is also a reality. Social progress frequently leads to scientific progress as the unseen becomes visible. Educators should engage students in the process of reinventing sex by examining the origins and cultural context of students' present knowledge. Thereafter, students may be introduced to research illuminating the unified nature of sex.

[1]Quoted in Laqueur, 1990, p. 24.

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Understanding Preconceptions

Seemingly simple questions can encourage critical reflection on sexual knowledge. For example, we may ask students the following:

- What determines sex?
- What determines gender?
- Is there a difference between sex and gender? If so, what is this difference?
- How are the sexes different?
- How are they similar?

In presenting these questions, I have found that students tend to see sex as absolute—as definitive. This view is elemental to their ideology, and they have difficulty responding to questions concerning the origins and "truth" of their knowledge. However, when reconsidered in the context of information challenging an absolute and binary view of sex, these questions evoke a lively response.

Genetic Determinants of Sex

In an attempt to understand what determines sex, reductionism leads us to the gene. Scientists commonly state that the presence of a Y chromosome determines a male; and its absence, a female. Thus, the separation between the sexes widens as science divides us into the "haves and the have nots." But what about the Y chromosome makes a person male? And what about the XX combination makes a person female? Further analysis of these questions not only leads students to a better understanding of the ongoing nature of genetic research, but also provides them with a glimpse into the unifying themes of female and male development.

At the turn of the decade, in 1990, the "male gene" was first reported and named SRY for the Sex determining Region of the Y chromosome. In the six

years that followed, its structure and function were further mapped. While the exact mechanisms and pathways of SRY action are incompletely delineated, sound hypothetical systems have been proposed (Figure 1). SRY initiates the transcription of Mullerian inhibiting substance. However, other factors likely mediate the induction (Haqq et al. 1994). Cascading events result in the degradation of precursors to the female reproductive tract. However, the annihilation of the female tract is only half of the process for the sexual development of a male fetus. In addition, the Wolffian duct must mature into the male reproductive tract and testes must form. SRY may also target SRA (Autosomal Sex Reversal factor) to stimulate the production of testosterone causing the growth of the testes (Haqq 1994).

At the turn of the decade, in 1990, females were still viewed as lacking—as developing in the absence of the Y chromosome. With the discovery of SRY the translation was speedy. Females now developed in the absence of SRY. Such development was and continues to be described as the "default mode." Yet, in 1994, two groups of scientists independently localized a region on the X chromosome—named DSS (Dosage Sensitive Sex reversal) or SRVX (Sex Reversing X)—which seems to proactively affect ovarian formation and which is not required for testis differentiation (Bardoni et al. 1994; Arn et al. 1994). The DDS ability to shadow the influence of the Y chromosome demonstrates its strength. Researchers found that XY individuals with feminized anatomy had functioning SRY genes and a duplication of DDS (Bardoni et al. 1994). In these cases the DDS gene outpowered the SRY gene, and the boys were born feminized.

The history of these advances provides a rich opportunity to explore the power of phraseology in scientific reporting. With little research and a great deal unknown, the scientific community was quick to describe females in negative terms such as "lacking," "absence" and "default." Yet, a thorough and updated analysis of the genetic basis for sexual development should leave the impression that there is fundamental similarity in the active development of both sexes.

Further exploration of the genetics of sexual development reveals additional information countering our binary view of sex. Most biology texts include discussions of genetic disorders resulting from nondisjunction of sex chromosomes. Educators should use this information to increase student understanding of what it means to be female and male. Debating how to sexually categorize individuals with XO, XXY and XYY genotypes may support the conclusion that a binary definition of sex based in genetics alone is insufficient.

Sexually Bipotential Embryos

The question, "when do we become male and female?" most often elicits the response, "at conception." Yet for the first six weeks of development XX and XY human embryos are anatomically identical. Containing both precursors to the female reproductive tract (Mullerian ducts) and precursors to the male reproductive tract (Wolffian ducts), embryos are sexually bipotential. During the seventh week of development the Y chromosome produces a protein promoting the differentiation of gonads into embryonic testes. Testes then release testosterone which promotes the growth of the male reproductive tract and Mullerian Inhibiting Substance (MIS) which causes the degeneration of the Mullerian Duct. Because the role of testosterone in development is well understood, female development is often explained as occurring in the absence of testosterone. Yet this ignores the historical lack of scientific research on female development, and some evidence suggesting that an increase in estrogen production during the seventh week may promote the growth of the Mullerian Duct (Fausto-Sterling 1985).

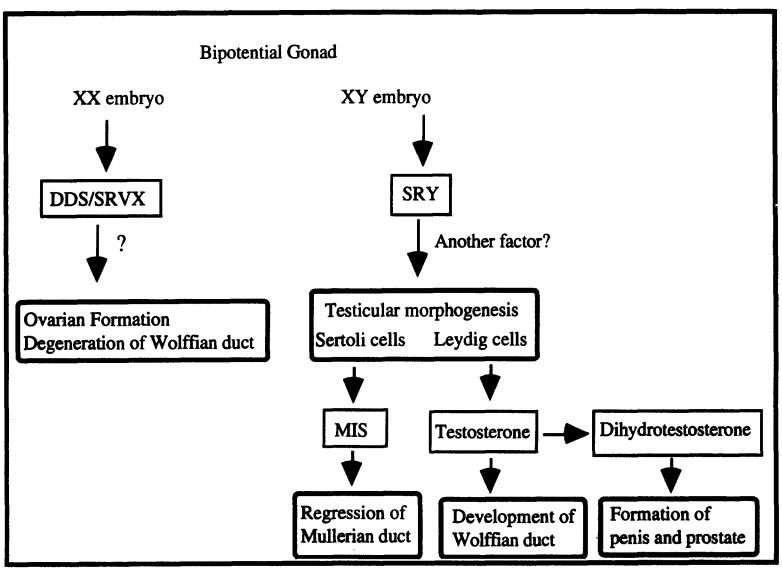

Figure 1. Sexual differentiation of most XX and XY embryos.

Not only are the internal reproductive tracts of XX and XY fetuses identical in early development, but also the external genitalia appear similar until after the tenth week of development. Educators should use diagrams of developing male and female genitalia to further discuss the similarities of male and female development. Once again, early fetal development of external or internal genitalia does not support a binary view of sex. Understanding

that men and women originate in fundamental similarity will allow students to begin envisioning the unity of the sexes.

Hormonal Determinants of Sex

Towards the end of the first trimester, a cascade of hormonal changes leads to the differentiation of XX and XY fetuses, potentially disrupting our view of sexual unity. Is a binary definition of sex emphasizing fundamental and significant differences now supported? Presenting students with information on the development of true and pseudo hermaphrodites will equip them with the knowledge to analyze this issue.

The Case of XY Girls

Testicular feminization is an androgen insensitivity in which testosterone receptors are defective. These XY individuals have functional testes that secrete testosterone. However, target cells do not respond to the hormone, resulting in feminized external genitalia. (Incomplete testicular feminization occurs when some, but not all, receptors are defective.) Cases of testicular feminization call into question the validity of notion that the presence of testosterone is the essence of masculinity. In addition, it is noteworthy that the gene for testosterone receptors lies on the X chromosome, causing X-linked inheritance of testicular feminization.

Five alpha reductase deficiency is a disorder in which XY embryos are unable to produce dihydrotestosterone (DHT) during fetal development. Because the synthesis of testosterone and MIS occurs normally, the result is female or ambiguous external genitalia with male internal genitalia. At puberty, testosterone, not DHT, serves as the masculinizing agent and induces development of the penis and scrotum. Young girls with this deficiency find that their voices deepen and their clitoris enlarges to become a penis during adolescence. While the molecular basis for this disorder is not fully established, mutations of SRY account for only sporadic cases, thereby suggesting that many others are caused by mutations of DDS (Arn et al. 1994; Bardoni et al. 1994). 5 alpha reductase deficiency provides an appropriate context in which to discuss societal understandings of gender and the psychological consequences of a gender role change at puberty.

Cases of feminized XY individuals demonstrate both the complexities of developmental pathways and the fragility and ambiguity of sex. They provide a rich opportunity to discuss the interaction between biological and sociological notions of sex.

The Case of XX Boys

Congenital adrenal hyperplasia is the disorder in which karyotypic females are exposed *in utero* to an excess of adrenal androgens. These individuals are born with ambiguous or masculinized external genitalia due to an enzymatic deficiency. The enzyme, 21-hydroxylase, is necessary for the synthesis of cortisol. Its deficiency results in the presence of large quantities of cortisol precursors (see figure 2 for an overview of the chemical process). These precursors are then converted into androgens, causing the development of external male genitalia despite the XX chromosomes. This process occurs after the degeneration of internal male ducts and before final formation of external sex organs. Thus the vaginal lips fuse to become a scrotum, and the clitoris develops into a penis. Therapy usually involves the administration of corticosteroids which suppress excess androgen secretion (through ACTH inhibition) so that subsequent female development can be normal. Cases of XX individuals serve as yet another example challenging binary definitions of sex.

To students first exposed to such sexual ambiguity, these cases appear impossible, contrived, even bizarre. However, the developmental complexity of sex determination demonstrates the need for perfect coordination among genes and hormones. The ease with which genitalia change from female to male (and vice versa) indicates that the presence or absence of hormones is not solely responsible for female or male development.

Hormones & Cycles

Most students characterize testosterone as a male hormone and estrogen as a female hormone. However, the hormonal difference between men and women is not qualitative. Not only do men possess

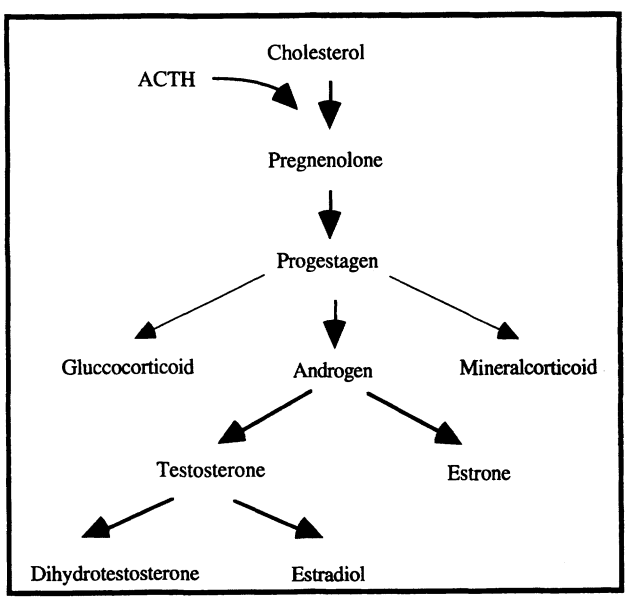

Figure 2. Chemical synthesis of hormones. High levels of gluccocorticoids have negative feedback effects on ACTH.

estrogen and women possess testosterone, but each hormone plays an important role in the pubescent development of both sexes. Estrogen, for example, is required for normal bone maturation and the feedback inhibition of gonadotropin secretion in men in addition to women (Smith et al. 1994).

To further emphasize the similarity in the sexes, students should examine the chemical structures of estrogen and testosterone and their derivation (Figure 2). Students are intrigued to discover that testosterone is a necessary intermediate in the synthesis of estrogen, and progestagens are an intermediate in the synthesis of both testosterone and estrogen. In the end, the difference between men and women is quantitative. Generally, female target cells convert more testosterone to estrogen while males convert more to dihydrotestosterone.

Most students have at least some rudimentary understanding of the female menstrual cycle. Textbooks emphasize female hormonal cycling and thus contribute to what appears to be a division between "being male" and "being female." This closely mirrors the public's perceptions of the menstrual cycle and its associated symptoms (such as PMS) which has been used historically to limit female access to jobs and opportunities. However, the sole presentation of female cycling does not justly reflect reality.

Like women, men experience hormonal cycles, and like women, performance levels vary within these cycles. Studies find the following trends:

- On a 24-hour basis, testosterone levels peak at between 4 and 6 a.m. (Poppy 1994).
- On a yearly basis, testosterone levels peak in the fall and drop in the spring (O'Brien 1992).
- Over a lifetime, testosterone peaks during infancy and adolescence.

The lesson here is the same as previously. There is plenty of hormonal evidence supporting a view of sexual similarity.

Conclusion

Reinventing sex is a complex yet necessary task. Understanding the social context and arbitrary nature of most definitions of sex is an important step in this process. In recognition of the impact science can have on social policies and values, we should challenge students to carefully consider the language they choose for defining sex. Taking this into account, I have devised the following criteria for constructing a fair and realistic understanding of sex:

1. Emphasize similarities in addition to differences.
2. When describing the differences that exist between sexes, note exceptions and variations.
3. Stress the active development of both sexes.
4. Note the flexibility in the development of sexes at each level of differentiation (chromosomal, hormonal, gonadal).
5. If possible, differentiate between societal notions of gender and biological notions of sex.

Before ending the discussion it is imperative that students return to the question of the significance of subtle definition differences. As educators we care a great deal about our disciplines, yet we cannot always expect the same from our students. While we may exalt pure knowledge, they may need the more concrete. Students should research social and political implications of definitions of sex. They may find examples in a variety of fields, including the International Olympic Committee's debate over whether to allow XY female athletes to compete.

In reinventing sex we are limited by language, inherently a social construct, and we are constrained by unfinished research. The power of reinventing sex can lie in its uncertainty and its ongoing evolution. We need not finish the task for our students, for they will be continuing it with theirs.

References

Arn, P., Chen, H., Tuck-Muller, C., Mankinen, C., Wachtel, G., Li, S., Shen, C. & Wachtel, S. (1994). SRVX, a sex reversing locus in Xp21.2–p22.11. *Human Genetics, 4,* 389–393.

Bardoni, B., Zanaria, E., Guioli, S., Floridia, G., Worley, K., Tonini, G., Ferrante, E., Chiumello, G., McCabe, E., Fraccaro, M., Zuffardi, O. & Camerino, G. (1994). A dosage sensitive locus at chromosome Xp21 is involved in male to female sex reversal. *Nature Genetics, 7*(4), 497–501.

Fausto-Sterling, A. (1985). *Myths of Gender, Biological Theories about Women and Men.* New York: Basic Books Inc.

Flieger, K. (1995). Testosterone: Key to masculinity and more. *FDA Consumer, 29*(4), 27–32.

Haqq, C., King, C., Ukiyama, E., Falsafi, S., Haqq, T., Donahoe, P. & Weiss, M. (1994). Molecular basis of mammalian sexual determination: Activation of Mullerian inhibiting substance gene expression by SRY. *Science, 266,* 1494–1500.

Laqueur, T. (1990). *Making Sex: Body and Gender from the Greeks to Freud.* Cambridge: Harvard University Press.

O'Brien, J. (1992). It's that time of the year. *Omni, 14*(11), 28–29.

Poppy, J. (1994). Timing is everything. *Men's Health, 9(9),* 188.

Smith, E., Boyd, J., Frank, G., Takahashi, H., Cohen, R., Specker, B., Williams, T., Lubahn, D. & Korach, K. (1994). Estrogen resistance caused by a mutation in the estrogen-receptor gene in a man. *New England Journal of Medicine, 331*(16), 1056–1061.