1. Rationale and Scope

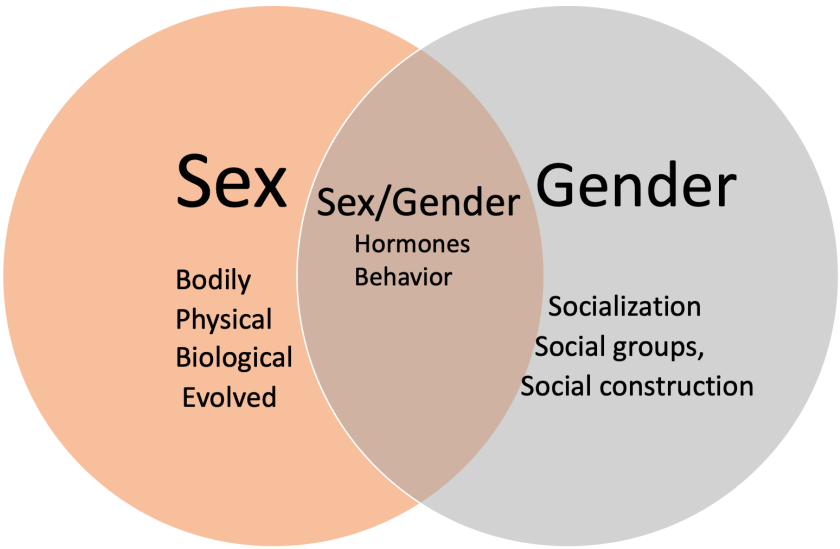
This module addresses the need for clarity in the biological discussion of the nature of sex which has been weaponized to deny the existence and rights of individuals that do not fit into the outdated concept that the sexes are strictly binary. Here we discuss the evidence for the incredible diversity of sex phenotypes in nature that is often overlooked or explained away as weird exceptions to the binary “rule”. We will learn that the complexity involved in building a sexual body, results in variation that cannot be neatly fitted into two distinct categories. Biology constantly grapples with the difficulty of explaining diversity, and often resorts to simplified categorization that allows scientists to converse and develop programs of inquiry. However, when we do so, we often forget that the categories are agreed upon for the purpose of description, and that they are not all encompassing and do not therefore explain all variation. Categories are also created by scientists and do not represent intrinsic properties of the objects or subjects of study. They are assigned. Ultimately every individual organism has unique characteristics and phenotypes that would make the task of general knowledge construction extremely difficult in the absence of simplification. However, as our knowledge in the field advances, Biologists are responsible for ensuring that our theoretical approaches change to better represent our growing understanding of biological phenomena in a socially responsible manner that honors the individual variation, rather than allowing “traditional” yet outdated explanations, to be used against people who challenge our neat yet incomplete explanations.

This module is a guide of our current biological understanding of sexual phenotypes that does not discard variation as an exception, but incorporates it as an expected outcome of complexity. It can be used as a pre-class reading to discuss and clarify Biological sex. Some of these ideas I have developed as part of a seminar class I teach on the Diverse Biology of Sex, others emerge from my study and research into the evolution of vertebrate genitalia. Some portions of this module have been modified to be published as part of an opinion piece for This View of Life: Sex and Gender (Genitalia are not binary or fixed either). This module is written for upper level undergraduate students, and assumes some working understanding of genetics, and development. It can also serve as a guide for those interested in teaching this topic more inclusively at the introductory biology level.

I have included a diversity of papers of the evolution of sex, but have not included the emerging science of the biology of gender. While there are legitimate criticisms to the difficulty of separating sex and gender and the influence of social environment on both, I will follow the American Psychological Association definition (2019), wherein “Gender refers to the attitudes, feelings, and behaviors that a given culture associates with a person’s biological sex […] Gender is a social construct and a social identity. […] Sex refers to biological sex assignment; use the term “sex” when the biological distinction of sex assignment (e.g., sex assigned at birth) is predominant. […] In some cases, there may not be a clear distinction between biological and acculturative factors, so

a discussion of both sex and gender would be appropriate". (American Psychological Association, 2019, p. 138). The latter is illustrated by Sari van Anders as a venn diagram where sex and gender do overlap, but not fully. A great example of how social groups and factors influence biological sex (the overlapping area), is the widespread occurrence of phenotypic plasticity in response to the social environment. This plasticity has been shown to influence hormone levels, gonadal size, gamete and genital morphology and some examples are discussed here. The study of the biological factors that can influence gender is in its infancy, but several studies on the influence of varying hormone levels early in development have started to suggest that varying levels of hormones early in life can affect gender expression later in life. While it is possible and even likely that some social animals that have complex cultures have a gender that is distinct from their sex, I will not discuss the concept of gender in this article. However I recommend "Different: Gender through the eyes of a Primatologist" by Frans de Waal for interesting ideas about gender in other animals.

Fig 1. Sari Van Anders's depicts sex and gender as separate but overlapping as shown in this Venn diagram. Redrawn from: Sari Van Ander's American Psychology Association.



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