2

Sex versus Gender

To most people, "sex" automatically implies "male" or "female." Not to a biologist. As we saw in the last chapter, sex means mixing genes when reproducing. Sexual reproduction is producing offspring by mixing genes from two parents, whereas asexual reproduction is producing offspring by one parent only, as in cloning. The definition of sexual reproduction makes no mention of "male" and "female." So what do "male" and "female" have to do with sex? The answer, one might suppose, is that when sexual reproduction does occur, one parent is male and the other female. But how do we know which one is the male? What makes a male, male, and a female, female? Indeed, are there only two sexes? Could there be a third sex? How do we define male and female anyway?

"Gender" also automatically implies "male" and "female" to most people. Therefore, if we define male and female biologically, do we wind up defining gender as well? Similarly, for adjectives like "masculine" and "feminine," can we define these biologically? Moreover, among humans, is a "man" automatically male and a "woman" necessarily female? One might think, yes, of course, but on reflection these key words admit lots of wiggle room. This chapter develops some definitions for all these words, definitions that will come in handy later on.

When speaking about humans, I find it's helpful to distinguish between

social categories and biological categories. "Men" and "women" are social categories. We have the freedom to decide who counts as a man and who counts as a woman. The criteria change from time to time. In some circles, a "real man" can't eat quiche. In other circles, people seize on physical traits to define manhood: height, voice, Y chromosome, or penis. Yet these traits don't always go together: some men are short, others are tenors, some don't have a Y chromosome, and others don't have a penis. Still, we may choose to consider all such people as men anyway for purposes like deciding which jobs they can apply for, which clubs they can join, which sports they may play, and whom they may marry.

For biological categories we don't have the same freedom. "Male" and "female" are biological categories, and the criteria for classifying an organism as male or female have to work with worms to whales, with red seaweed to redwood trees. When it comes to humans, the biological criteria for male and female don't coincide 100 percent with present-day social criteria for man and woman. Indeed, using biological categories as though they were social categories is a mistake called "essentialism." Essentialism amounts to passing the buck. Instead of taking responsibility for who counts socially as a man or woman, people turn to science, trying to use the biological criteria for male to define a man and the biological criteria for female to define a woman. However, the definition of social categories rests with society, not science, and social categories can't be made to coincide with biological categories except by fiat.

MALE AND FEMALE DEFINED

To a biologist, *"male" means making small gametes, and "female" means making large gametes.* Period! By definition, the smaller of the two gametes is called a sperm, and the larger an egg.* Beyond gamete size, biologists don't recognize any other universal difference between male and female. Of course, indirect markers of gamete size may exist in some species. In mammals, males usually have a Y chromosome. But

*A gamete is a cell containing half of its parent's genes. Fusing two gametes, each with half the needed number of genes, produces a new individual. A gamete is made through a special kind of cell division called meiosis, whereas other cells are made through the regular kind of cell division, called mitosis. When two gametes fuse, the resulting cell is called a zygote. A fertilized egg is a zygote.

whether an individual is male or not comes down to making sperm, and the males in some mammalian species don't have a Y chromosome. Moreover, in birds, reptiles, and amphibians, the Y chromosome doesn't occur. However, the gamete-size definition is general and works throughout the plant and animal kingdoms.

Talk of gamete size may seem anticlimactic. Among humans, for example, centuries of poetry and art speak of strength and valor among men, matched by beauty and motherhood among women. Saying that the only essential difference between male and female is gamete size seems so trivial. The key point here is that "male" and "female" are biological categories, whereas "man" and "woman" are social categories. Poetry and art are about men and women, not males and females. Men and women differ in many social dimensions in addition to the biological dimension of gamete size.

Yet, biologically, the gamete-size definition of "male" and "female" is far from anticlimactic. In fact, this definition is downright exciting. One could imagine species whose members all make gametes of the same size, or several gamete sizes—small, medium, and large—or a continuum of gamete sizes ranging from small to large. Are there any such species? Almost none. Some species of algae, fungi, and protozoans have gametes all the same size. Mating typically occurs only between individuals in genetic categories called "mating types." Often there are more than two mating types.[1] In these cases, sex takes place between the mating types, but the distinctions of male and female don't apply because there is only one gamete size.[2] By contrast, when gametes do come in more than one size, then there are generally only two sizes, one very small and the other very large. Multicellular organisms with three or more distinct gamete sizes are exceedingly rare, and none is known to have a continuum of gamete sizes.

More than two gamete sizes occur in some colonial single-celled organisms, the protozoans. In the green ciliate *Clamydomonas euchlora,* the cells producing gametes may divide from four to sixty-four times. Four divisions result in relatively big gametes, whereas sixty-four divisions produce lots of small gametes. The cells that divide more than four times but less than sixty-four make various intermediate-sized gametes. Another ciliate, *Pandorina,* lives in colonies of sixteen cells. At reproduction, some cells divide into eight big gametes and others into sixteen small gametes. However, any two of these can fuse: two big ones, one big and one small, or two small ones.[3] These species are at the borderline between single-celled and multicellular organisms.

In the fruit fly *Drosophila bifurca* of the southwestern United States, the sperm is twenty (yes, twenty) times longer than the size of the male who made it! These sperm don't come cheap. The testes that make these sperm comprise 11 percent of the adult male's weight. The sperm take a long time to produce, and males take twice as long to mature as females. The sperm are so expensive that males conserve them, "offering" them to females in small amounts, leading to a one-to-one gamete ratio.[4] So much for the vision of one huge egg surrounded by zillions of tiny sperm. Although giant sperm are a marvelous curiosity, the important finding is that some species of *Drosophila* have three sperm sizes—one giant type and two smaller varieties that overlap somewhat, totaling four gamete sizes (three sperm sizes plus one egg size). In *Drosophila pseudoobscura* from Tempe, Arizona, the tail of the big sperm is 1/3 millimeter long, and the tail lengths of the two small types are 1/10 and 1/20 millimeter.

Female *Drosophila* in some species can store sperm for several days or even up to a month after mating. About one-third of the sperm are the giant type; the remaining two-thirds are small. Females preferentially store the large sperm, although some small sperm are stored too. Females also control which sperm are used for fertilization and preferentially select the large sperm. Whether the small sperm are ever used for fertilization has been hard to demonstrate. The amount of material in a large sperm is about one hundred times that of a small sperm. Therefore, to break even, the fertilization rate for small sperm needs to be only 1/100 of the fertilization rate of large sperm, and this low rate would be hard to detect.[5]

If different individuals made the different-size gametes, we could have as many as four sexes in *Drosophila,* one for each gamete size. In this species, however, every male apparently makes all three of the sperm sizes in the same ratio, so all the males are apparently the same. If further research reveals that the sperm makers differ in the ratio of sperm sizes they produce, we will have discovered a species with more than two sexes. Such a discovery would not violate any law of nature, but it would

be very rare and would certainly make headlines. So, for practical purposes, male and female are universal biological categories defined by a binary distinction between small and large gametes, sperm and egg.

Why are two gamete sizes practically universal in sexually reproducing species? The current theory imagines a hypothetical species starting with two mating types that produce gametes of the same size. These gametes fuse with each other to produce a zygote, and each gamete contributes half the genes and half the cytoplasm needed by the zygote. Then the gamete in one of the mating types is hypothesized to evolve a smaller size to increase quantity while sacrificing quality. The gamete in the other mating type responds by evolving a larger gamete size to compensate for the lowered quality of the small gametes now being made by its counterpart. Overall, this back-and-forth evolutionary negotiation between the mating types with respect to gamete size culminates in one mating type making the tiniest gametes possible—gametes that provide genes and nothing else, whereas the other mating type makes gametes large enough to provide genes as well as all the cytoplasm the zygote needs to start life.[6]

This little story of how the gamete binary originates is completely conjectural and untested, and points to the need for much further thought on such an important issue. This story also leaves unexplained why some groups, such as fungi, persist with only one gamete size, and why rare groups such as *Drosophila* occur with multiple sperm sizes.

GENDER DEFINED

Up to now, we've come up with two generalizations: (1) Most species reproduce sexually. (2) Among the species that do reproduce sexually, gamete size obeys a near-universal binary between very small (sperm) and large (egg), so that male and female can be defined biologically as the production of small and large gametes, respectively. Beyond these two generalizations, the generalizing stops and diversity begins!

The binary in gamete size doesn't extend outward. The biggest error of biology today is uncritically assuming that the gamete size binary implies a corresponding binary in body type, behavior, and life history. No binary governs the whole individuals who make gametes, who bring

them to one another for fertilization, and who interact with one another to survive in a native social context. In fact, the very sexual process that maintains the rainbow of a species and facilitates long-term survival automatically brings a cornucopia of colorful sexual behaviors. Gender, unlike gamete size, is not limited to two.[7]

"Gender" usually refers to the way a person expresses sexual identity in a cultural context. Gender reflects both the individual reaching out to cultural norms and society imposing its expectations on the individual. Gender is usually thought to be uniquely human—any species has sexes, but only people have genders. With your permission, though, I'd like to widen the meaning of gender to refer to nonhuman species as well. As a definition, I suggest: *Gender is the appearance, behavior, and life history of a sexed body.* A body becomes "sexed" when classified with respect to the size of the gametes produced. Thus, gender is appearance plus action, how an organism uses morphology, including color and shape, plus behavior to carry out a sexual role.

Now we're free to explore the zoological (and botanical!) counterpart of human gender studies. So, we may ask: How much variety occurs in gender expression among other species? Let's take some favorite stereotypes and see. We'll look mostly at vertebrates; even more variety occurs with invertebrates and plants.

An organism is solely male or female for life. No, the most common body form among plants and in perhaps half of the animal kingdom is for an individual to be both male and female at the same, or at different times during its life. These individuals make both small and large gametes during their lives.

Males are bigger than females, on the average. No, in lots of species, especially fish, the female is bigger than the male.

Females, not males, give birth. No, in many species the female deposits the eggs in the pouch of the male, who incubates them until birth. In many species, males, not females, tend the nest.

Males have XY chromosomes and females XX chromosomes. No, in birds, including domesticated poultry like chickens, the reverse is true. In many other species, males and females show no difference in chromosomes. In all alligators and crocodiles, some turtles and lizards, and the occasional fish, sex is determined by

the temperature at which the eggs are raised. A female can control the sex ratio among her offspring by laying eggs in a shady or a sunny spot.

Only two genders occur, corresponding to the two sexes. No, many species have three or more genders, with individuals of each sex occurring in two or more forms.

Males and females look different from one another. No, in some species, males and females are almost indistinguishable. In other species, males occur in two or more forms, one of which resembles a female, while the others are different from the female.

The male has the penis and the female lactates. No, in the spotted hyena, females have a penislike structure externally identical to that of males, and in the fruit bat of Malaysia and Borneo, the males have milk-producing mammary glands.[8]

Males control females. No, in some species females control males, and in many, mating is a dynamic interaction between female and male choice. Females may or may not prefer a dominant male.

Females prefer monogamy and males want to play around. No, depending on the species, either or both sexes may play around. Lifelong monogamy is rare, and even within monogamous species, females may initiate divorce to acquire a higher-ranking male.

One could tick off even more examples of gender stereotypes that are often thought to be "nature's way" but that have no generality within biology. Instead, let's look closer at the lives of these organisms to see whether what they do makes sense to us. Be prepared, though, to shrug your shoulders and wonder about the mystery of life.

Note that by defining gender as how an organism presents and carries out a sexual role, we can also define masculine and feminine in ways unique to each species. "Masculine" and "feminine" refer to the distinguishing traits possessed by most males and females respectively. Cross-gender appearance and behavior are also possible. For example, if most females have vertical stripes on their bodies and males do not, then a male with vertical stripes is a "feminine male." If most males have antlers and females do not, then a doe with antlers is a "masculine female."

Politically, locating the definition of male and female with gamete size

keeps society's gender categories at arm's length from biology's sex binary. We don't have to deny the universality of the biological male/female distinction in order to challenge whether the gender of whole organisms also sorts into a male/female binary. In humans specifically, a gender binary for whole people is not clear-cut even though the difference between human sperm and egg is obvious—a size ratio of about one million to one.