# 3. Many Ways of Reproducing

Sexual reproduction, while widespread, is by no means the only way for organisms to reproduce. Many organisms including plants, fungi, microbes and even some vertebrates reproduce without sex, producing offspring that carry the full complement of the parent DNA. Asexual organisms reproduce by budding, mitosis and cell division, and/or spore formation.

Sexual reproduction by definition requires both meiosis and fertilization. Meiosis is the cellular division process that produces reproductive cells with half the parent complement of DNA (haploid cells), as opposed to mitosis where cellular division produces cells that have the same DNA complement as the parents. The reproductive cells are called gametes, and they can be the same size in all organisms of a given species (isogamy), or different sizes with some organisms producing larger ones and others producing smaller ones (anisogamy). Only when gametes are of different sizes do we refer to those organisms as having a sex. During fertilization, the gametes of parental genotypes merge to form a zygote that will become a new organism, restoring the diploid DNA. However, some organisms such as fungi produce gametes, and require two parental genotypes to combine to form a new organism, but they can have thousands of mating types, and generally can exchange genetic material with any individual in the population that has a different mating type from their own. While we could refer to this phenomenon as fungi having thousands of sexes, we do not, because we have defined the sexes as a dichotomous system, where one individual of each mating type (male and female) contributes gametes towards fertilization. However, biological reality seems to get in the way of enforcing our categories even in this basic definition of sex.

***The Bird with Four Sexes***

The white throated sparrow is a common bird in North America, and recent research has uncovered the existence of four distinct sexes with two types of males and two types of females. While males make sperm and females make eggs, the merging of the gametes from males and females is not successful unless those individuals have a different variation of a supergene that is found in Chromosome 2 (not in the sex chromosomes). This supergene influences behavior and appearance broadly: one version results in aggressive white striped individuals, and the other in nurturing, non-aggressive and tan individuals. Successful reproduction only results when parental individuals have two different versions of the same gene. So a female that has the aggressive white supergene version can only reproduce successfully  with males that have the tan nurturing supergene version. Males that are aggressive and white are not viable mates, meaning that each female and male mating type can only mate with 25% of the members of the population rather than with the usual 50%.  For this reason, there are four identifiable sexes in this bird.  Of note is that white throated

sparrows are exceedingly common birds that have been studied for decades. It is likely that there are many more diverse sexual systems that challenge our narrow definitions of sex, but they have yet to be discovered and studied in depth. Anne Fausto Sterling has written an essay on a similar bird, the ruff (Calidris pugnax), that has been studied in depth in Norway because of their beautiful mating displays and plumages.  As it turns out ruff have 3 distinct male morphs, and one female morph.

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