6 Sex and sexual selection


Sexual reproduction is an evolved trait

- Recombination is a consequence of sexual reproduction.
  - Recombination during meiosis occurs because of independent assortment of chromosomes into gametes and crossing over within chromosomes.
  - Recombination does not change allele frequencies but creates new combinations of alleles of different genes.
  - Because of recombination, offspring produced by sexual reproduction differ in genotype from their parents and from one another.
  - Although sexual reproduction occurs only in eukaryotes, bacteria and viruses have other mechanisms of recombination.

There is great variety in modes of sexual reproduction

- Isogamy vs. anigamy: isogamous species produce gametes of the same size and form; anisogamous species produce gametes that differ in size and form. Some fungi and algae are isogamous. All other sexually reproducing species are anisogamous. The sex that produces the larger gamete is defined to be the female.
- Hermaphroditic vs. separate males and females: most plants are hermaphroditic; most animals have separate sexes. Some hermaphrodites can self-fertilize; some cannot.
- Genetic vs. environmental sex determination: in humans, as in many other species with separate sexes, sex is determined by genotype. In mammals, XX individuals are female; XY individuals are male. In birds, males are ZZ and females are ZW. A variety of other genetic mechanisms are found in other groups. In some species of plants and animals, sex is determined by the environment. For example, in most species of turtles and in all crocodilians, the sex of an individual depends on the temperature of the egg during a critical period of development. Usually males are produced when eggs are incubated at low temperatures and females are produced when eggs are incubated at higher temperatures.
- Capable or incapable of asexual reproduction: Some plants and animals can produce new genetically identical individuals by budding or fission. Some plants can produce seeds asexually (apomixis). Some animals can produce diploid eggs asexually (parthenogenesis). Both apomixis and parthenogenesis result in offspring that are genetically identical to their mother. Some species never engage in sexual reproduction. For example, several species of whiptail lizards, including the endangered California species, Cnemidophorus hypertythrus, are comprised of females that reproduce only by parthenogenesis.
- Many species, including aphids, can reproduce both sexually and asexually. Typically they undergo several generations of asexual reproduction followed by a one generations of sexual reproduction.
• Do not confuse self-fertilization with parthenogenesis or apomixis. Self-fertilization occurs when a female gamete is fertilized by a male gamete from the same individual. Siblings produced by self-fertilization have genotypes that differ from one another and from their parent. In contrast, offspring produced by parthenogenesis or apomixis are (except for mutation) identical to one another and to their parent.

❖ **Sexual modes of reproduction persist despite the two-fold cost of sex**

• Because sexual reproduction requires that equal numbers of sons and daughters be produced, females who reproduce asexually will on average produce twice as many daughters as females who reproduce sexually. This is the two-fold cost of sexual reproduction.
• The fact that many species retain the capacity for both sexual and asexual reproduction tells us that sexual reproduction could be eliminated by natural selection. The question is why sexual reproduction persists.
• One answer is that genetically diverse offspring are better able to survive in different conditions. Sexual reproduction is often associated with dispersal, as in *Pilobolus* mushroom discussed by Dr. Feldman. Dispersing individuals would be expected to encounter environmental conditions different from those experienced by their parents.
• A second answer is that asexually reproducing species are not able to eliminate deleterious mutations as efficiently as sexually reproducing species. Although completely asexual species have evolved, they do not seem to be very successful and do not have large geographic ranges.

❖ **Sexual selection**

➢ *Darwin’s theory of sexual selection explains sexual dimorphism.*
• Darwin recognized that some features of plants and animals cannot be explained by natural selection because they do not make species better adapted to their environments. Instead, sexually dimorphic characters such as the peacock’s tail, the antlers of a deer, or the horn of a stag beetle, seem to reduce chances of survival.
• Darwin recognized that the struggle for existence was both a struggle to survive and a struggle to reproduce.

➢ *Darwin noted that sexual dimorphism was associated with male-male competition and female choice.*
• In birds of paradise, sexual dimorphism is associated with female choice. The extravagant plumage of males serves no purpose other than being attractive to females.
• Big-horn sheep are an example of sexual dimorphism associated with male-male competition. The large horns of males are used in fights with other males. Females mate with the winners.

➢ *Anisogamy explains Darwin’s generalization that sexual dimorphism results from competition by males for females.*
• In anisogamous species, many more male gametes than female gametes are produced. The reproductive capacity of females is limited by their ability to produce eggs; all the eggs they produce can be fertilized. The reproductive capacity of males is limited
by their ability to fertilize eggs, not by the number of gametes they produce. Therefore, sexual selection results from a struggle among males for access to females.

**Questions**

- **Which pair of words best fills the blanks in the following sentence?** Sexual selection results from competition between ________ because of ________.
  a. species, the struggle for existence
  b. males, anisogamy.
  c. females, anisogamy.
  d. chromosomes, polyploidy.
  e. alleles, genetic drift.

- **Which statement best explains the two-fold cost of sexual reproduction?**
  a. There are twice as many males as females in sexually reproducing species.
  b. Asexually reproducing species evolve half as fast.
  c. Asexually reproducing females can produce twice as many daughters as can sexually reproducing females.
  d. There are twice as many asexually reproducing species as sexually reproducing species.
  e. Mutation rates in asexually reproducing species are twice as high as they are in sexually reproducing species.

- **Which statement best defines sexual selection?**
  a. The competition among males for food.
  b. The competition among males for access to females.
  c. The competition among asexually reproducing females.
  d. The competition among offspring for access to their mothers.
  e. None of the above.

- **Which answers best fill the blanks in the following sentence?** In plants, apomixis results in offspring that are genetically ________ their parent, while self-fertilization results in offspring that are genetically ________ their parent.
  a. the same as; different from.
  b. different from; the same as.
  c. sexual offspring of; asexual offspring of.
  d. larger than; smaller than.
  e. None of the above.