[Template:About](/wiki/Template:About" \o "Template:About) [Template:Pp-semi-indef](/wiki/Template:Pp-semi-indef) [Template:Pp-move-indef](/wiki/Template:Pp-move-indef) [Template:Use dmy dates](/wiki/Template:Use_dmy_dates) [Template:Sex (biology) sidebar](/wiki/Template:Sex_(biology)_sidebar) [Organisms](/wiki/Organism) of many [species](/wiki/Species) are specialized into [male](/wiki/Male) and [female](/wiki/Female) varieties, each known as a **sex**.[[1]](#cite_note-1) [Sexual reproduction](/wiki/Sexual_reproduction) involves the combining and mixing of [genetic](/wiki/Genetics) traits: specialized [cells](/wiki/Cell_(biology)) known as [gametes](/wiki/Gamete) combine to form offspring that inherit traits from each parent. Gametes can be identical in form and function (known as [isogamy](/wiki/Isogamy)), but in many cases an asymmetry has evolved such that two sex-specific types of gametes (heterogametes) exist (known as [anisogamy](/wiki/Anisogamy)).

Among humans and other [mammals](/wiki/Mammal), males typically carry XY [chromosomes](/wiki/Chromosome), whereas females typically carry XX chromosomes, which are a part of the [XY sex-determination system](/wiki/XY_sex-determination_system). Other animals have a [sex-determination system](/wiki/Sex-determination_system) as well, such as the [ZW sex-determination system](/wiki/ZW_sex-determination_system) in birds, and the [X0 sex-determination system](/wiki/X0_sex-determination_system) in insects.

The gametes produced by an organism are determined by its sex: males produce male gametes (spermatozoa, or [sperm](/wiki/Sperm), in animals; [pollen](/wiki/Pollen) in plants) while females produce female gametes ([ova](/wiki/Ovum), or egg cells); individual organisms which produce both male and female gametes are termed [hermaphroditic](/wiki/Hermaphrodite). Frequently, physical differences are associated with the different sexes of an organism; these [sexual dimorphisms](/wiki/Sexual_dimorphism) can reflect the different reproductive pressures the sexes experience. For instance, [mate choice](/wiki/Mate_choice) and [sexual selection](/wiki/Sexual_selection) can accelerate the evolution of physical differences between the sexes.

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## Overview[[edit](/index.php?title=(none)&action=edit&section=1)]

[thumb|The male gamete (](/wiki/File:Sperm-egg.jpg)[sperm](/wiki/Sperm)) fertilizing the female gamete ([ovum](/wiki/Ovum)) One of the basic properties of life is reproduction, the capacity to generate new individuals, and sex is an aspect of this process. Life has evolved from simple stages to more complex ones, and so have the reproduction mechanisms. Initially the reproduction was a replicating process that consists in producing new individuals that contain the same genetic information as the original or parent individual. This mode of reproduction is called *asexual*, and it is still used by many species, particularly unicellular, but it is also very common in multicellular organisms.[[2]](#cite_note-2) In sexual reproduction, the genetic material of the offspring comes from two different individuals. As sexual reproduction developed by way of a long process of evolution, intermediates exist. Bacteria, for instance, reproduce asexually, but undergo a process by which a part of the genetic material of an individual (donor) is transferred to an other (recipient).[[3]](#cite_note-3) Disregarding intermediates, the basic distinction between asexual and sexual reproduction is the way in which the genetic material is processed. Typically, prior to an asexual division, a cell duplicates its genetic information content, and then divides. This process of cell division is called [mitosis](/wiki/Mitosis). In sexual reproduction, there are special kinds of cells that divide without prior duplication of its genetic material, in a process named [meiosis](/wiki/Meiosis). The resulting cells are called [gametes](/wiki/Gametes), and contain only half the genetic material of the parent cells. These gametes are the cells that are prepared for the sexual reproduction of the organism.[[4]](#cite_note-4) Sex comprises the arrangements that enable sexual reproduction, and has evolved alongside the reproduction system, starting with similar gametes (isogamy) and progressing to systems that have different gamete types, more notably a big ovum (female gamete) and a small male gamete (sperm).[[5]](#cite_note-5) In complex organisms, the sex organs are the parts that are involved in the production and exchange of gametes in sexual reproduction. Many species, particularly animals, have sexual specialization, and their populations are divided into male and female individuals. Conversely, there are also species in which there is no sexual specialization, and the same individuals both contain masculine and feminine reproductive organs, and they are called [hermaphrodites](/wiki/Hermaphrodites). This is very frequent in plants.[[6]](#cite_note-6)

## Evolution[[edit](/index.php?title=(none)&action=edit&section=2)]

[Template:Main](/wiki/Template:Main) [Template:Double image](/wiki/Template:Double_image) Sexual reproduction first probably evolved about a billion years ago within ancestral single-celled [eukaryotes](/wiki/Eukaryotes).[[7]](#cite_note-7) The reason for the evolution of sex, and the reason(s) it has survived to the present, are still matters of debate. Some of the many plausible theories include: that sex creates variation among offspring, sex helps in the spread of advantageous traits, that sex helps in the removal of disadvantageous traits, and that sex facilitates repair of germ-line DNA.

Sexual reproduction is a process specific to [eukaryotes](/wiki/Eukaryote), organisms whose cells contain a nucleus and mitochondria. In addition to animals, plants, and fungi, [other eukaryotes](/wiki/Protist) (e.g. the [malaria](/wiki/Malaria) parasite) also engage in sexual reproduction. Some bacteria use [conjugation](/wiki/Bacterial_conjugation) to transfer genetic material between cells; while not the same as sexual reproduction, this also results in the mixture of genetic traits.

The defining characteristic of sexual reproduction in eukaryotes is the difference between the gametes and the binary nature of fertilization. Multiplicity of gamete types within a species would still be considered a form of sexual reproduction. However, no third gamete is known in multicellular animals.[[8]](#cite_note-8)[[9]](#cite_note-9)[[10]](#cite_note-10) While the evolution of sex dates to the prokaryote or early eukaryote stage,[[11]](#cite_note-11) In some cases, including in the fruit fly, it is the number of X chromosomes that determines sex rather than the presence of a Y chromosome (see below).

In [birds](/wiki/Bird), which have a [ZW sex-determination system](/wiki/ZW_sex-determination_system), the opposite is true: the W chromosome carries factors responsible for female development, and default development is male.[[30]](#cite_note-30) In this case ZZ individuals are male and ZW are female. The majority of butterflies and moths also have a ZW sex-determination system. In both XY and ZW sex determination systems, the sex chromosome carrying the critical factors is often significantly smaller, carrying little more than the genes necessary for triggering the development of a given sex.[[31]](#cite_note-31) Many [insects](/wiki/Insect) use a sex determination system based on the number of sex chromosomes. This is called [X0 sex-determination](/wiki/X0_sex-determination_system)—the 0 indicates the absence of the sex chromosome. All other chromosomes in these organisms are diploid, but organisms may inherit one or two X chromosomes. In [field crickets](/wiki/Field_cricket), for example, insects with a single X chromosome develop as male, while those with two develop as female.[[32]](#cite_note-32) In the nematode [*C. elegans*](/wiki/Caenorhabditis_elegans) most worms are self-fertilizing XX hermaphrodites, but occasionally abnormalities in chromosome inheritance regularly give rise to individuals with only one X chromosome—these X0 individuals are fertile males (and half their offspring are male).[[33]](#cite_note-33) Other insects, including [honey bees](/wiki/Honey_bee) and [ants](/wiki/Ant), use a [haplodiploid sex-determination system](/wiki/Haplodiploidy).[[34]](#cite_note-34) In this case diploid individuals are generally female, and haploid individuals (which develop from unfertilized eggs) are male. This sex-determination system results in highly biased [sex ratios](/wiki/Sex_ratio), as the sex of offspring is determined by fertilization rather than the assortment of chromosomes during meiosis.

### Nongenetic[[edit](/index.php?title=(none)&action=edit&section=9)]

[thumb|](/wiki/File:Ocellaris_clownfish.JPG)[Clownfish](/wiki/Clownfish) are initially male; the largest fish in a group becomes female

For many species, sex is not determined by inherited traits, but instead by environmental factors experienced during development or later in life. Many [reptiles](/wiki/Reptile) have [temperature-dependent sex determination](/wiki/Temperature-dependent_sex_determination): the temperature embryos experience during their development determines the sex of the organism. In some [turtles](/wiki/Turtle), for example, males are produced at lower incubation temperatures than females; this difference in critical temperatures can be as little as 1–2 °C.

Many [fish](/wiki/Fish) change sex over the course of their lifespan, a phenomenon called [sequential hermaphroditism](/wiki/Sequential_hermaphroditism). In [clownfish](/wiki/Clownfish), smaller fish are male, and the dominant and largest fish in a group becomes female. In many [wrasses](/wiki/Wrasse) the opposite is true—most fish are initially female and become male when they reach a certain size. Sequential hermaphrodites may produce both types of gametes over the course of their lifetime, but at any given point they are either female or male.

In some [ferns](/wiki/Fern) the default sex is hermaphrodite, but ferns which grow in soil that has previously supported hermaphrodites are influenced by residual hormones to instead develop as male.[[35]](#cite_note-35)

## Sexual dimorphism[[edit](/index.php?title=(none)&action=edit&section=10)]

[Template:Main](/wiki/Template:Main) [thumb|](/wiki/File:Male_and_female_pheasant.jpg)[Common pheasants](/wiki/Common_pheasant) are sexually dimorphic in both size and appearance.

Many animals and some plants have differences between the male and female sexes in size and appearance, a phenomenon called [sexual dimorphism](/wiki/Sexual_dimorphism). [Sex differences in humans](/wiki/Sex_differences_in_humans) include, generally, a larger size and more body hair in men; women have breasts, wider hips, and a higher body fat percentage. In other species, the differences may be more extreme, such as differences in coloration or bodyweight.

Sexual dimorphisms in animals are often associated with [sexual selection](/wiki/Sexual_selection) – the competition between individuals of one sex to mate with the opposite sex.[[36]](#cite_note-36) Antlers in male deer, for example, are used in combat between males to win reproductive access to female deer. In many cases the male of a species is larger than the female. Mammal species with extreme sexual size dimorphism tend to have highly [polygynous](/wiki/Polygyny) mating systems—presumably due to selection for success in [competition](/wiki/Intraspecific_competition) with other males—such as the [elephant seals](/wiki/Elephant_seal). Other examples demonstrate that it is the preference of females that drive sexual dimorphism, such as in the case of the [stalk-eyed fly](/wiki/Stalk-eyed_fly).[[37]](#cite_note-37) Other animals, including most insects and many fish, have larger females. This may be associated with the cost of producing egg cells, which requires more nutrition than producing sperm—larger females are able to produce more eggs.[[38]](#cite_note-38) For example, female [southern black widow](/wiki/Southern_black_widow) spiders are typically twice as long as the males.[[39]](#cite_note-39) Occasionally this dimorphism is extreme, with males reduced to living as [parasites](/wiki/Parasite) dependent on the female, such as in the [anglerfish](/wiki/Anglerfish). Some plant species also exhibit dimorphism in which the females are significantly larger than the males, such as in the moss [*Dicranum*](/wiki/Dicranum)[[40]](#cite_note-40) and the liverwort [*Sphaerocarpos*](/wiki/Sphaerocarpos).[[41]](#cite_note-41) There is some evidence that, in these genera, the dimorphism may be tied to a sex chromosome,[[41]](#cite_note-41)[[42]](#cite_note-42) or to chemical signalling from females.[[43]](#cite_note-43) In birds, males often have a more [colourful](/wiki/Animal_coloration) appearance and may have features (like the long tail of male peacocks) that would seem to put the organism at a disadvantage (e.g. bright colors would seem to make a bird more visible to predators). One proposed explanation for this is the [handicap principle](/wiki/Handicap_principle).[[44]](#cite_note-44) This hypothesis says that, by demonstrating he can survive with such handicaps, the male is advertising his [genetic fitness](/wiki/Fitness_(biology)) to females—traits that will benefit daughters as well, who will not be encumbered with such handicaps.

## See also[[edit](/index.php?title=(none)&action=edit&section=11)]

* [Sex and gender distinction](/wiki/Sex_and_gender_distinction)
* [Sex assignment](/wiki/Sex_assignment)

## References[[edit](/index.php?title=(none)&action=edit&section=12)]

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## Further reading[[edit](/index.php?title=(none)&action=edit&section=13)]

[Template:Refbegin](/wiki/Template:Refbegin)

* [Template:Cite journal](/wiki/Template:Cite_journal)
* [Template:Cite book](/wiki/Template:Cite_book)
* [Template:Cite book](/wiki/Template:Cite_book)
* [Template:Cite book](/wiki/Template:Cite_book) *N.B*.: One of many books by this pioneering authority on aspects of human sexuality.
* [Template:Cite book](/wiki/Template:Cite_book)
* [Template:Cite book](/wiki/Template:Cite_book)

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## External links[[edit](/index.php?title=(none)&action=edit&section=14)]

[Template:Sister project links](/wiki/Template:Sister_project_links)

* [Template:Books-inline](/wiki/Template:Books-inline)
* [Human Sexual Differentiation](http://www.gfmer.ch/Books/Reproductive_health/Human_sexual_differentiation.html) by P. C. Sizonenko

[Template:Sex (biology)](/wiki/Template:Sex_(biology))

[Template:Authority control](/wiki/Template:Authority_control)

[Category:Biological processes](/wiki/Category:Biological_processes) [Category:Sex](/wiki/Category:Sex)