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Sex reversal in chickens[1]

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Every once in a while you hear a story about a hen that changed into a cock. Such stories are often meet with skepticism, but sex reversals do, in fact, occur, although not very frequently. To date, however, spontaneous sex reversal from male to female has not been reported.

In spontaneous sex reversal, only the phenotype[3] is altered. Genetically, the bird remains a female, but externally it appears male.

Differences between the sexes

A young chicken is called a chick. A male chicken is a cock or a cockerel, depending on its age. Similarly, a female chicken is called a pullet or a hen. The age at which a pullet becomes a hen and a cockerel becomes a cock depends on what type of chicken is being raised. Purebred poultry producers have very age-specific definitions. A chicken is a cockerel or pullet if it is less than one year of age. After one year of age, the chicken is referred to as a hen or cock. In the commercial chicken industry a female chicken is called a hen after it begins egg production (around five months of age). A sexually mature male chicken (again, around five months of age) is referred to as a rooster.

The observable differences in secondary sex characteristics between the male and female chicken are referred to as sexual dimorphism.

Typical differences between a rooster (Figure 1) and a hen (Figure 2) include:

- The male has a larger body, comb, and wattles than the female.
- In single-comb birds the male's comb will be turgid and stand erect, whereas the female's may flop over on one side.
- The male has a larger, more developed spur than does the female.
- Roosters crow, while hens do not.
- In multicolored varieties, the male will have more variety of coloring in his plumage than the female.
- The male has longer and more pointed hackle feathers than the female.
- The male and female both have main tail feathers, but only the male has saddle feathers.

As often happens, there are exceptions to these differences. Males of two breeds of chicken, the

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Campine and the Sebright, for example, have female plumage. The female plumage pattern is dependent upon the presence of estrogen to femininize the feather follicle and direct feather formation to produce more rounded feathers in the hackles and tail. These two breeds possess a single gene mutation that codes for excessive aromatase production in several tissues, including the feather follicles. Since aromatase is the enzyme responsible for the conversion of androgens to estrogens, the feather follicles of males of Sebright and Campine breeds have excess estrogen production. The level of estrogen in the feather follicles is sufficient to femininize the growing feathers. Castration of Sebright or Campine males removes the source of androgens for conversion to estrogen in the feather follicles causing their female plumage to revert to the male phenotype.

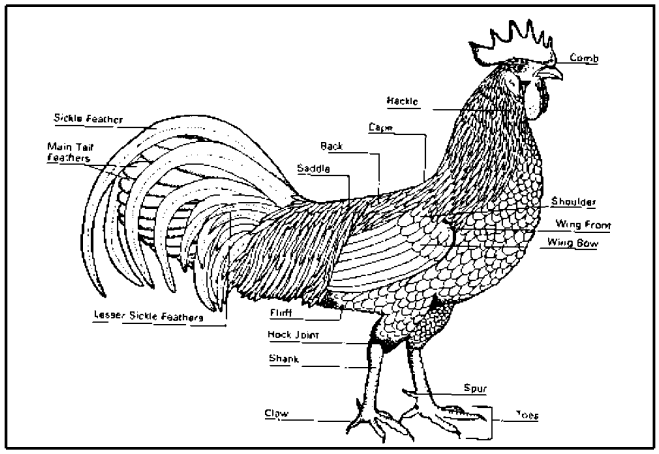

Figure 1. Parts of the male chicken. From Poultry Science & Production, by R.E. Moreng and J.S. Avens

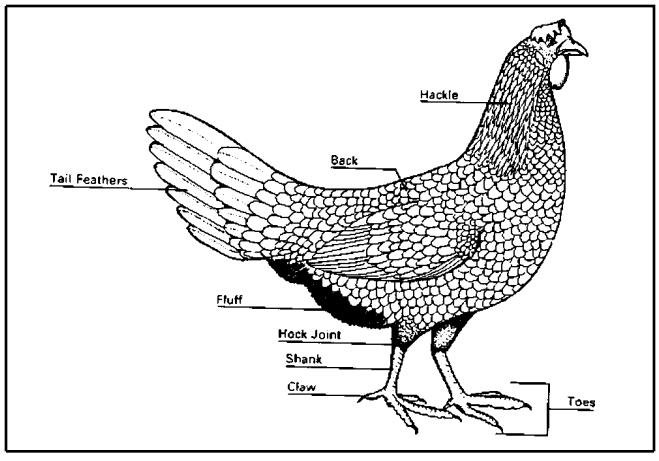

Figure 2. Parts of the female chicken. From Poultry Science & Production, by R.E. Moreng and J.S. Avens

Genotype or Phenotype?

Sexual differentiation in birds is directed by the presence or absence of the W chromosome, similar to the Y chromosome in humans. Genetically, male birds are homozygous, ZZ, and the female bird is heterozygous, ZW. This is opposite from mammals where the male is heterozygous, XY, and the female homozygous, XX.

Within a few days after fertilization, the female chicken embryo can be identified by the accumulation of primordial germ cells in the left gonad (primary sexual gland). By the tenth day of incubation, the gonads are sufficiently differentiated to be recognized upon autopsy. Throughout embryonic development, however, there are no external characteristics that identify the sex of the chick. At hatch, male and female chicks are the same weight and, with the exception of specific genetic variants in down color or feather length, neither males nor females exhibit any distinguishing secondary sexual characteristics.

The acquisition of secondary sexual characteristics as birds mature is a consequence of the hormonal secretions from the testes and ovary. The development of secondary sexual characteristics, representing the phenotypical expression of the sex genes, is dependent upon the production of both androgens and estrogens.

Androgens are required to induce growth of the comb and wattles in roosters. They are also responsible for full expression of the characteristic voice of the rooster. The growth of spurs, however, is independent of testicular and ovarian secretion. Their growth is determined by the genetic sex of the bird.

The female plumage color is dependent upon the presence of estrogens to femininize the feather follicle and direct feather formation to produce a more rounded feather in the hackles and tail. In breeds of chickens that are sexually dimorphic for feather color, the estrogens are also responsible for the reduction in pigmentation in many of the feather tracts.

How does sex reversal occur?

Most cases of spontaneous sex reversal are the result of a disease condition which has resulted in damage to the left ovary. Typically, female chickens only have one functional ovary, the left one. The right ovary and oviduct are present in the embryonic stages of all birds, but typically do not develop in chickens.

In general, spontaneous sex reversal has been described as the result of pathological conditions (e.g., ovarian cyst or tumor, diseased adrenal glands) which cause the left ovary to regress. Residual tissue in the right ovary proliferates in the absence of a functional left ovary. This regenerated right gonad is known as an ovotestis and may contain tissue characterisitics of the ovary, the testes, or both. There are reports of these ovotestes producing semen capable of fathering offspring. Most, however, will never lay an egg or sire offspring.

The "ovotestes" are steroidogenically functional and secret androgens, as well as estrogen. As a result, the bird develops male secondary characteristics. So while the bird is genotypcially female, it will be phenotypically male.

Additional Notes:

3. Genotype = Actual traits coded in paired genes
Phenotype = The observable expression of traits coded in paired genes