

# CONCERNING POULTRY

## FEATHER COLOUR Green, Violet and White



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Above: A White Bresse pullet. Photo: Aviculture Europe.

### The Colours of Chicken Feathers

The colouring of our fancy poultry breeds derives from the Jungle Fowl; a type of colouring that is known as 'wild type' colouring, which is Nature's way of distributing pigment to make the males attractive to females, and to camouflage the females when they are incubating their eggs. This colouration is based on only two forms of pigmentation: black and red.

Feathers get their colours by the coloured pigments that are present in the Keratin. These are the melanins - usually Eumelanin and Pheomelanin - which range from black to light tan and also produce grays. The pigments responsible for the red base colour are pheomelanins, while eumelanins provide the black based colours.

Now you may think: our chickens exhibit a much greater range of colours than blacks, browns, reds, oranges and yellows. That is true, however, the violets, greens and other iridescent variations arise from the physical presence of minute structures on the surface of the feathers, which reflect only one wavelength of light. Violet and White are normally a structural colour, like green, although green may often be a mixture of structural and pigmental iridescence.

Albinism is caused by the lack of pigment in some or all of a bird's feathers.

## Green and violet

The feathers of only a very few birds, among which the Eiders, like the Common Eider (*Somateria mollissima*), produce a green pigment which is a mixture of black and yellow compounds, giving a green olive colour. The plumage of the chicken either shows green or violet reflections due to structural variations of the keratinised surface of the feathers, and they are not the actual expression of a pigment different from the usual present pigment. Furthermore, we should not forget that the melanin has a very high index of refraction, greater than that of the surrounding keratin: seen at the microscope in a dark field, the single structures of eumelanin are iridescent, endowed with metallic colours that change according to the angle of illumination. The purple reflections and the green reflections, which look as if they change their metallic brightness, may also occur because of this, although they are habitually attributed to Tyndall's diffusion\* taking place on the surface of the feather.

*\* Note: Tyndall studied the diffusion of light by large molecules and dust, known as the Tyndall effect, and he performed experiments demonstrating that the sky's blue colour results from the scattering of the Sun's rays by molecules in the atmosphere.*



**Above: Green and violet sheen in the feathers of a cockerel. Photo: Elio Corti.**

Melanic structures have a well defined and characteristic shape for every species, with noticeable differences according to the sex. It is easy to deduce that not only the structure of the feather is hereditary, but necessarily also the shape assumed by the melanin is hereditary. Both for green and violet reflections the correct anatomical structure of the feather is very important; also its regular and rapid growth, which is crucial for a proper structure.

**Right: Violet barring in a black feather. Photo: AE.**

According to the breeds, the mature birds can show a plumage with violet or green reflections. If the structure is made for producing reflections of a beautiful beetle green, this will also show in their normally grown offspring, that is, regularly and quickly grown. If on the contrary our chickens grow in an irregular way, violet reflections will occur. After

The structural differences of a feather are hereditary; this is continuously demonstrated by those breeders skilled in selecting the birds that will give an offspring that will also show the green reflection that is wanted by the Poultry Standard. Even though the heritability is not completely demonstrated, the available data point out that the green reflections obey to the Mendelian laws.





the moult, the violet reflections can become green, if the regrowth of the feathers happens in a regular and quick way. (Henny Gankema, 1994, personal communication.)

**Right: Violet striping in the green shining tail feathers of a cockerel. Photo AE.**

Also Clive Carefoot is thinking that the purple bars, visible in quite a lot of chickens with black plumage and green reflections, are caused by a slack growth of the feathers. The incidence of purple bars can reflect the variability of the meteorological conditions, since the rhythm of growth could be altered by a



food ration, which is not always consistent with the individual necessities; only after having produced the heat necessary for vital processes, the organism will place the excess available energy at the disposal of the feathers. Therefore, with an irregular climate, we have to feed profusely, especially if it concerns young or re-feathering birds. This criterion is not always applicable, since the individual sensibility to the environment assumes a decisive importance, because the answer is not identical in all the subjects. It seems that the female's plumage of the 'wild type' is so sensitive to the ambient temperature that the punctuation is due to the eumelanogenesis during daytime, while the pheomelanin is synthesized at night, when the speed of growth of the feather is decreasing.

In spite of the adverse climatic conditions able to modify the colour of the reflexes, the susceptibility to bad meteorological conditions is clearly hereditary. So those breeders that always selected the birds with the more bright green reflections, based on both intuition and experience, were right.

**Right: A blue Limousin pullet. Photo AE.**

### Blue

What we call the 'blue' colour in chickens is a rather grey tone; a dilution of the black pigment, caused by the *Blue* gene that distorts black pigment granules which makes them look blue. The exact shade of blue is fairly unpredictable and can range from very pale to slate grey. The Blue gene *Bl* is incomplete dominant and doesn't breed true. When there are two blue genes, *Bl / Bl*, the effect of the dilution is doubled to splash (white with only a few dark spots).





**Left: Grey Jungle fowl.**  
**Photo: Jan Willem Schrijvers.**

### White

The completely white plumage of the domestic fowl is a characteristic that is not present in any of the four species of Jungle fowl considered as its possible ancestors. Even assuming that the Grey Jungle fowl - *Gallus sonnerati* - may somehow have helped the emergence of the domestic fowl, the white of its plumage never reaches, in both males and females, an extension that makes the subject an easy prey of natural enemies.

Therefore, the white extended to the whole plumage is the result of a mutation that does not meet the needs of the Genus *Gallus*' camouflage, able to ensure their survival in natural conditions. White is called a 'structural colour' resulting from the refraction or separation of the components of white light by the structure of the feather. In white feathers, the whole feather structure simply reflects back the whole colour spectrum. White feathers have no melanin and when such a feather is observed under a powerful microscope, the surface structure appears crystalline, resembling cut glass or snow, clearly capable of reflecting all visible light.

We don't have to bundle every kind of white from a genetic perspective. A white columbian Brahma, a Chabo white black tail, a white Leghorn, a Silky white, a silver partridge Dutch Bantam, are all chickens that have the white colour; more or less extended, sometimes so extensive as to have erased any trace of pigment in the plumage. Even a good splash chicken may occur entirely white, or



nearly so. Genes involved in removing the red or black - or both characteristic pigments of the feathers of the genus *Gallus* - change each time, and in the splash subject even the blue gene is responsible for this.

To understand better, we will analyze the varieties we have mentioned, and we will see at least one gene responsible for a particular distribution of red and black, and some genes are able to eliminate the red or black or both pigments.

**Left: Columbia Brahma cock.**  
**Photo and owner: Bobo Athes.**

### *Brahma columbia or white ermine*

The gene columbia - *Co* - is not a part of the genetic heritage of the wild fowl and therefore is also a mutation, same as the genes responsible for the totally white plumage. In a 'red black columbia' chicken, this gene *Co* forces the Black to be relegated to the neck hackle, tail feathers, flight feathers and to the



feet, when they are feathered. The rest of the plumage is pigmented Red. In scientific terms the black pigment is called 'eumelanin' and the red 'pheomelanin'.

With the introduction of the silver gene in the 'red black columbia' - a term not entirely correct, but that we use to understand better - the pheomelanin is canceled and we get the 'white black columbia'. The black areas remain the same, as the silver gene is antagonist only to the gold gene, both sex-linked as residing on the sex chromosomes.

**Right: 2 Silver partridge hens. Photo AE.**

#### *Silver varieties*

This paragraph may be dedicated to all those chickens that are classified in the Poultry Standard in silver under the golden colour; for instance the Dutch Bantam and the Leghorn. In silver, the distribution of the white areas corresponds exactly to those areas that were red before the silver gene –S-, which stands for silver, was introduced.



A peculiarity that hobby breeders must know is that the salmon breast of the golden female is not turned into silver, as this gene is unable to determine the disappearance of pheomelanin-breasted hens, since this gene is not able to determine the disappearance of the pheomelanin from the female's breast; a pheomelanin which probably has different chemical characteristics from the pheomelanin present in the remaining areas of the mantle, both of rooster and hen.

#### *Splash or White splashed with black and blue*

The term *splash* means the colour commonly referred to as off-white plumage. The classic splash birds are naturally black. With the addition of a single gene of the blue - *Bl* – the eumelanin is diluted, giving the feathers, which had to be black, a mostly slate gray colour. But sometimes the feathers are almost black, or have a pastel colour that we call 'dove blue'.

However, with the addition of two blue genes - *Bl / Bl* – the eumelanin is diluted to the point of disappearing, or nearly, in all parts of the plumage.

Splash white chickens are exceptional, because the Blue gene is sometimes weak, so even if it is present in a double dose in the genes, it rarely fails to inhibit the formation of eumelanin in all the feathers.



**Left: Two dark blue Orpington pullets and one splash.  
Owner: Harmen de Kok (NL).**



But if you are lucky enough to run into the proper gene, a gold black laced Wyandotte can turn into a nice white laced bird with two Blue genes.

However, the chickens mentioned above should not be called gold white laced in this manner since the gene for blue, in double dose -  $BI / BI$  – also dilutes the gold, so the intensity and hue of the central part of the gold feathers is a bit washed out as if, instead of the Blue, the Dominant White gene were used, which is active both in black and red. In this case the colour should be referred to as Yellow white laced or Buff white laced, and we shall soon see why.

**Right: Buff white laced Wyandottes.  
Owner: Fam Hogewerf (NL)**

#### *White Leghorn*

Here is a classic example of white plumage due to the Dominant White gene. Theoretically we are led to believe that this gene, which has received the dominant symbol ( $I$  – from: Inhibitor), written with a capital letter, is a gene that in a single dose is able to remove any pigment from the feathers.

Things are not so, as anyone will confirm who has experienced a cross between a golden Leghorn and a white Leghorn. In the F1 generation of chicks we obtain Pile birds, which are red and white (or rather, yellow and white, as we have pointed out about the yellow white laced Wyandotte) with a special charm. Black areas become white and the red is diluted with a variable intensity.

We summarized the action of the dominant White gene, which, as a single dose, inhibits the black and also - but not always - dilutes the red. In double dose, i.e. in homozygous chickens, we should see the total disappearance of black and red. But this does not happen except through a fierce selection, probably capable of accumulating a number of modifier genes in the offspring, capable of cooperating with the gene to obtain a white bird. The same statement is also valid for blue and splash.

This is a characteristic of the white Leghorn. But often also of the White Laced Red and Jubilee Cornish, Chamois Polish, Buff White Laced Wyandotte, the Pile Old English Game and Modern Game, Naked-Neck / Cou nu du Forez and others.

**Above left: American White Leghorns.  
Left: Pile Twente Fowl. Photos AE.**





### *Silky white*

The recessive white is truly dominant and victorious, but only if owned in double dose, thus in homozygotes. You can be sure that a chicken that possesses two recessive genes will not show any traces of pigment in its plumage, although sometimes a few minor colour spots can be observable.

**Left : White Silky cockerel. Photo AE.**

The gene that allows the colouring is signed with  $C +$ , which means colour, certainly possessed by the Jungle fowl, which are basically coloured black and red. Since the recessive white is a mutation and thus unable to compete with a single gene  $C +$ , its symbol is  $c$ .

The recessive white is, for instance, present in Cochin, Cochin bantam,

Dorking, Chabo, Langshan, Orpington, Silkie, Sultan, Wyandotte, Bresse, Gatinais, Plymouth Rock, Menorca, Jersey Giants. The down of the recessive white chicks is very variable: it may be light or it can be almost as dark as in male Barred Plymouth Rock. In other cases the  $c / c$  chicks have an amelanotic down colour.

**Right: White Sultan pullet.**  
**Photo: Klaas van der Hoek.**



**Left: White Sabelpoot bantam pullet.**  
**Photo AE.**

It is not yet clear which are the genotypes that form the background to these changes of down colour, and you can only say that the gene  $E$  is present as the chick's down looks gray. The intensity of gray appears due to modifier genes, although on average the females appear darker than the males.



**Right: White Minorca.**  
**Photo: Freddy Bettink.**

Using the recessive white gene will never be possible to obtain Pile, as a single *c* gene is inactive towards Red as well as towards Black, and it is the suppression of black plumage that features of Pile.

To get your white chickens whiter, you could add one or more of the following genes: Blue, for removing black spots, or Silver, for removing reddish sheen in the plumage.

If you want to breed a perfectly white chicken, you have to combine science and patience.

More on chicken colour genetics: <http://kippenjungle.nl/basisEN.htm#basisEN>



**Above: White Cochon hen. Photo and owner: Bobo Athes.**