

# Chromosome Linkages

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## Linkages

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## Chromosome Linkages Table

The following linkage map table is based on the following books:

1. Crawford (ed.) (1990) *Poultry Breeding and Genetics*.
2. Stevens, L. (1991) *Genetics and Evolution of the Domestic Fowl*.
3. Muir and Aggrey (ed.) (2003) *Poultry Genetics, Breeding and Biotechnology*, CABI Publishing.

# All hashed data is from the last book (Muir & Aggrey), & is based on the following quote from this book (page 499):

*The classical linkage groups I, IV and Z correspond to chromosomes 1, 2 and Z, and linkage group II to linkage group E22C19W28. These results also clearly show that several of the linkages reported in the past are incorrect. For example, naked neck and blood group P are located not on chromosome 1 (linkage group 1) but on chromosome 3 and extension of eumelanin (MC1R) is not located on chromosome 1 but located on microchromosome 11 (Takeuchi et al., 1996; Sazanov et al., 1998; Kerje et al., 2003, unpublished).*

\*Note, the recessive white locus (Tyrosinase) map reference is from Dr Ron Okimoto (pers. comm.)

\*Recent sequencing of the yellow skin allele:

Eriksson J, Larson G, Gunnarsson U, Bed'hom B, Tixier-Boichard M, et al. (2008) *Identification of the Yellow Skin Gene Reveals a Hybrid Origin of the Domestic Chicken*. PLoS Genet 4(2): e1000010.  
doi:10.1371/journal.pgen.1000010

Quotes from the above article:

*...yellow skin was previously assigned to chromosome 24. An examination of this chromosomal region revealed an obvious candidate gene for yellow skin, BCDO2 located at position 6.26–6.29 Mbp.*

\*Due to the above information, I've included w locus on Microchromosome 24 (\*) in the table below. It is obvious from growing discrepancies in data below that the old Linkage Maps in Crawford, etc (which most of the table below is based on) are outdated and need significant revision.

Locus	Map Unit Distance	Locus Description	Scientific Name - DNA sequenced	Comments/Ref
<i>Group I : (# Chromosome 7)</i>				
Cp		Creeper		
	0.4			
			MNR2	

R		Rose Comb	(homeodomain protein) (& CCDC108 coiled-coil domain containing 108 )	Imsland et al. 2012
	30			
U		Uropygial		linkage not given to lav
----- ----- ----- -	--	---		-----
the below not linear				
lav	32.5	Lavender	MLPH (melanophilin)	lav 32.5 map units to R Vaez et al., 2008
	?			linkage not given between lav & Mp
Mp	16			Mp 16 map units to R
the above not linear				
<i>Group II (# linkage group E22C19W28- new)</i>				
fr		Fray		
	46			
Cr		Crest	HOXC8 (Homeobox protein C8)	Wang et al., 2012
	12.5			
I, I <sup>D</sup> , I <sup>S</sup>		Dominant White, Dun, Smoky	PMEL17 (Melanocyte protein Pmel 17)	Kerje et al., 2004
	17			
E		Erin	KRT75 (keratin)	Ng et al. 2012

r		FLIZZIE	( $\alpha$ -keratin)	Ng et al., 2012
<i>Group III: (# Chromosome 1)</i>				
w		Yellow Skin		*sequenced on Microchromosome 24
	22			
Ea-H		Blood Group H		
	21			
se		Sleepy Eye		se is 45 map units from P
	3			
Ea-J		Blood Group J		
p	36			
O		Blue Egg-Shell		
	4			
Cha		Charcoal		
	0.3			
P		Pea Comb	SOX5 (SRY-box 5)	*Carefoot believed E locus linked to P -43 cM, this later determined incorrect. Wright et al, 2009. Sato et. al, 2010.
	32			
Db		Dark Brown	SOX10 (SRY-box 10)	Gunnarsson et al. 2011.
	12			
MI		Melanotic		MI is 45 + map units from P
	10			
Pg		Pattern		
	?			
T		Tardy		
	?			

Ea-P		Blood Group P		(#Chromosome 3 -new)
	28			
Na		Naked Neck		(#Chromosome 3 -new) Pitel et al. 2000
q	43			
h		Hookless - Silkiness		possible Chromosome 3. Dorshorst et al 2010
	11			
F1		Flightless		
	?			
c		Recessive White	TYR (tyrosinase)	Tyrosinase (#Chromosome 1 -new) Chang et al, 2006. Sato et. al, 2007.
<i>Group IV (#Chromosome 2 -new)</i>				
D <sup>V</sup> , D <sup>C</sup>		Duplex Comb		chromosome 2 - Dorshorst et al 2010
	27			
M		Multiple Spurs		
	33			
Po, Po <sup>d</sup>		Polydactyly, Duplicate	Lmbr1 (limb region 1)	chromosome 2 - Dorshorst et al 2010  Might be SHH (Sonic HedgeHog) instead of Lmbr1 Dunn et al., 2011
Rp		Rumpless	Irx1 and Irx2 (Iroquois homeobox)	Rooksana et al, 2012

<i>#Chromosome 3 -new</i>				
Ea-P		Blood Group P		(#Chromosome 3 -new)
	28			
Na		Naked Neck	BMP12/GDF7 (bone morphogenetic protein 12)(growth differentiation factor 7)	(#Chromosome 3 -new) Mou et al. 2011
	43			
h		Hookless - Silkiness		possible Chromosome 3. Dorshorst et al 2010
	11			
Fl		Flightless		possible Chromosome 3. due to close linkage with h - hookless
<i>Group V: (Z Chromosome -sex chromosome)</i>				
ro		Restricted Ovulator		
	3			
sh		Shaker		
p	14			
n		Naked		
	7			
px		Paroxysm		
	1.9			
ln		Liver Necrosis		
	3.1			
dw <sup>B</sup> , dw <sup>M</sup> , dw		Dwarf	GHR (growth hormone receptor)	Hull et al, 1999
	2.4			

	3.4			
wl		Wingless		
	0.6			
pn		Prenatal Lethal		
	3			
ev21		Endogenous viral 21	EV21 (ALVE21) (Endogenous viral 21)	Tixier-Boichard et al., 1997. Bacon et al., 1988
K <sup>n</sup> , K <sup>s</sup> , K		Slow Feathering	PRLR and SPEF2 (prolactin receptor) (sperm flagellar 2)	Elferink et al., 2008
	1.1			
S, S <sup>al-s</sup> , s <sup>al</sup>		Silver, Imperfect Albinism	SLC45A2 (solute carrier family 45 member 2)	Gunnarsson et al, 2007.
	4			
lk		Lady Killer		
	12			
Li		Light Down		
	7			
y		Recessive White Skin		
	13			
br		Brown Eye		
q	27			
Id, id <sup>a</sup> , id <sup>c</sup> , id <sup>M</sup>		Dermal Melanin Inhibitor	VCAN (Versican) or B4GALT1 (beta1,4- Galactosyltransferase)	Might be VCAN or B4GALT1 - not substantiated. Dorshorst et al, 2010
	14			
B <sup>Sd</sup> , B		Sex-linked Dilution, Barring	CDKN2A/B (Cyclin-dependent kinas inhibitor 2A/B)	Hellström et al, 2010
	13			
ko		Head Streak		
<i>Group VI: (W Chromosome -sex chromosome- females only)</i>				

<i>Group VII (Chromosome 6)</i>				
the below not linear				
Gc, Alb				
Ade-A				
Pgm-2				
the above not linear				
ig		Inhibitor of Gold (Cream)	COMTD1 (catechol-O-methyltransferase domain containing 1)	Eriksson, 2012
<i>Group VIII (Chromosome 7)</i>				
Ade-B			adenine synthesis B	
<i>Group X (Microchromosome 17)</i>				
p				
B-G				
Ea-B				
	0.4			
B-F		MHC		
R-Rs 1				
B-L				
lr-GAT				
NOR		Nucleolar organiser region		
q				
Ea-B				



<i>Chromosome 8</i>				
		fishy taint	FMO3 (flavincontaining mono-oxygenase 3)	Honkatukia et al. 2005 Hamid et al, 2012
<i>Chromosome 10</i>				
Hf		Henny- feathering	CYP19A1 (cytochrome P450, family 19, subfamily A, polypeptide 1)	ref: OMIA
<i>#Microchromosome 11</i>				
E, E <sup>R</sup> , E <sup>R</sup> - Fay, e <sup>Wh</sup> , e <sup>+</sup> , e <sup>b</sup> , e <sup>s</sup> , e <sup>bc</sup> , e <sup>y</sup> , e <sup>q</sup>		E Series	MC1R (melanocortin-1 receptor)	Takeuchi et al. 1996. Kerje et al., 2003. Ling et al., 2003
	26			
mo		Mottled		ref. Brumbaugh & Hollander, 1965
<i>Microchromosome 12</i>				
Bl		Blue	MITF	*possible candidate - not sequenced in chickens. Minvielle et al., 2010
<i>Microchromosome 13</i>				
Pti		Feathered legs		Chromosome 13 - Dorshorst et al 2010
<i>#Microchromosome 15</i>				
E+		E+ T+ B+	TBX1, partial	Deak et al

Et	Ear tuft	GNB1L (T-box 1)	KOOKSANA et al, 2012
<i>Microchromosome 20</i>			
Fm	Fibromelanosis	EDN3 (Endothelin 3)	Chromosome 20 - Dorshorst et al 2010  *might be EDN3 - not substantiated Dorshorst et al., 2011. Shinomiya et al., 2011.
<i>*Microchromosome 24</i>			
w	Yellow skin	BCDO2 (beta-carotene dioxygenase 2)	*see ref. above Eriksson et al., 2008

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