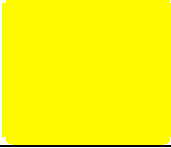
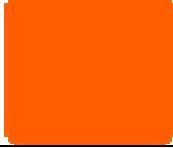
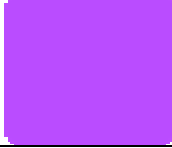
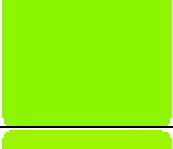
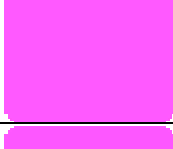
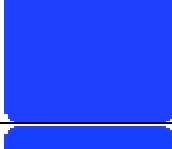
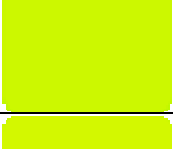
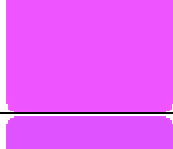


Don's Handy Dandy Do-It-Yourself Rose Pigment Color Chart

sinensiachrome R G B 101 0 135		apocycopene carboxylate R G B 252 255 0		zeaxanthin,β,β- carotene,β- kryptoxanthin R G B 255 133 0		peonidin glucoside R G B 215 0 255	
auroxanthin R G B 164 255 51		neoxanthine violaxanthin R G B 255 255 0		lycopene R G B 255 92 0		cyanidin rosafluene* R G B 200 0 255	
ζ-carotene R G B 165 255 48		neurosporeneR G B 255 250 0		pelargonin R G B 255 0 89		peonidin R G B 193 0 255	
sinensiaxanthin R G B 172 255 36		latoxanthin R G B 255 245 0		callistephin R G B 255 0 140		delphinidin glucoside** R G B 164 0 255	
apocarotenol apozeaxanthin R G B 175 255 31		Epilutein,karpoanth in,lutein,krypto- xanthin,latoxanthin R G B 255 229 0		pelargonodin glucoside R G B 255 0 217		malvidin** R G B 138 0 255	
auroxanthin R G B 180 255 23		antheraxanthin R G B 255 219 0		pelargonidin R G B 251 0 255		delphinidin**R G B 124 0 255	
apocycopeneolR G B 190 255 10		β,ε-carotene R G B 255 173 0		cyanin R G B 244 0 255		rosacyanin- A2*** R G B 91 0 255	
latochrome luteoxanthin neochrome R G B 198 255 0		β-citaurin R G B 255 163 0		peonin R G B 237 0 255		rosacyanin- A1*** R G B 84 0 255	
(8R)- mutaxanthin R G B 218 255 0		β,ω-carotene R G B 255 148 0		chrysanthemin oxycoccicyanin R G B 229 0 255		*fluorescent emission wavelength (it glows!) **These compounds have not yet been found in roses. ***rosacyanins <i>have</i> been found in roses and are more blue than the delphinidins!	
(8S)- mutaxanthin R G B 221 255 0		rubixanthin R G B 255 143 0		cyanidin glucoside R G B 222 0 255			

Most colors are based on λ_{abs} given in "The chemistry of rose pigments" by By Conrad Hans Eugster and Edith Marki-Fischer, Angewandte Chemie Int. Ed. Engl. 30 (1991) 654-672. Apparent absorptions were calculated by average. Rosacyanin values are from "Two novel blue pigments with ellagitannin moiety, rosacyanins A1 and A2, isolated from the petals of *Rosa hybrida*", Tetrahedron 62 (2006) 9661-9670. λ_{abs} of malvidin and the delphinidins are from "Chemical and Functional Properties of Food Components" by Zdzislaw E. Sikorski, CRC Press, 2002. Apparent absorptions were converted to RGB values using the "Wavelength To RGB" applet by Miguel Moreno, downloaded from <http://miguelmoreno.net/sandbox/wavelengthtoRGB/default.aspx> on October 30, 2008. Listed RGB values are the complements of the apparent absorption peaks. Created by Don Holeman. Please send corrections and additions to: don@holeman.org.

Don's Handy Dandy Do-It-Yourself Rose Pigment Color Chart

From the article "Fun With Color" published in the Winter, 2008-2009 Rose Hybridizers Association Newsletter.

Pigment	Avg. max.λ abs, nm	Swatch	Pigment	Avg. max. λ abs, nm	Swatch
Rosafluene (invisible)	340		ε,ω-carotene	445	16
(9Z),(8R)-sinseachrome	398	1	antheraxanthin	447	17
(9Z),(8S)-sinseachrome	398	1	β,ε-carotene	456	18
(8S,8'S)-auroxanthin	400	2	β-citaurin	458	19
(9Z),(8R,8R')-auroxanthin	400	2	β,ω-carotene	461	20
(8S,8'R)-auroxanthin	400	2	rubixanthin	462	21
ζ-carotene	401	3	zeaxanthin	464	22
sinensiaxanthin	406	4	β,β-carotene	464	22
10'-apo-β-caroten-10'-ol	408	5	β-kryptoxanthin	464	22
10'-apo-β-zeaxanthin-10'-ol	408	5	lycopene	472	23
	411	6	pelargonin	497	24
10'-apolycopene-10'-ol	416	7	callistephin	501	25
(8'R)-latochrome	423	8	pelargonodin-5-β-D-glucoside	507	26
(8R)-luteoxanthin	423	8	pelargonidin	511	27
(8'R)-neochrome	423	8	cyanin	513	28
(8'S)-latochrome	423	8	peonin	515	29
(8S)-luteoxanthin	423	8	chrysanthemin	517	30
(8'S)-neochrome	423	8	oxycoccicyanin	517	30
	424	9	cyanidin-3,5-β-D-glucoside	519	31
(8R)-mutaxanthin	427	10	peonidin-5-β-D-glucoside	521	32
(8S)-mutaxanthin	428	11	cyanidin	525	33
10'-apolycopene-10'-carboxylic acid	439	12	Rosafluene (emission)	525	33
neoxanthine	440	13	peonidin	527	34
violaxanthin	440	13	delphinidin-3-glucoside**	535	35
neurosporene	441	14	malvidin* ***	542	36
latoxanthin	442	15	delphinidin** (Merck Index 10th ed.)	544	37
3'-epilutein	445	16	delphinidin** (Nollet)	546	37
karpoxanthin	445	16	delphinidin-3,5-diglucoside**	552	38
lutein	445	16	rosacyanin A2 ***	555	39
α-kryptoxanthin	445	16	rosacyanin A1 ***	557	40

Table 1. Average absorption wavelengths of rose pigments and indexes to the corresponding color swatch ²⁴. Human vision can detect wavelengths between 380 nm and 740 nm.

*methanolic HCl, The color at higher pH may be different.

**not yet identified in roses

*** pH 6

References cited in Fun With Color

In my article "Fun With Color" I've made a personal comment or two but, except as otherwise noted, all the genuine information in the article comes from *The chemistry of rose pigments*, reference 2.

1. Chapin, H. "Flowers are Red". *Living Room Suite*, Elektra Records (1978). Lyrics listed at <http://harrychapin.com/music/flowers.shtml> downloaded December 18, 2008. See the performance at <http://www.youtube.com/watch?v=noVC5Jt2Gu8> downloaded December 18, 2008.
2. Eugster, C.H., Märki-Fischer, E. "The chemistry of rose pigments" *Angewandte Chemie International Edition in English*. 30 6 654 – 672. See the abstract at <http://www3.interscience.wiley.com/journal/106587486/abstract?CRETRY=1&SRETRY=0> downloaded December 18, 2008.
3. Viraraghaven V. Rose "Pigments & Rose Breeding: The findings of C.H. Eugster & E. Marki-Fischer, and their application" *Rose Hybridizers Association Newsletter* 35 1 12 (2004).
4. Fukui, Y et al. "Two novel blue pigments with ellagitannin moiety, rosacyanins A1 and A2, isolated from the petals of *Rosa hybrida*" *Tetrahedron* 62 (2006) 9661–9670.
5. Spectral data from Swain, T. "Flavonoids" in Goodwin, TW *Chemistry and Biochemistry of Plant Pigments*, p. 167 Academic Press (1965); Sikorski ZE (contributor) *Chemical and Functional Properties of Food Components*, p. 219, CRC Press (2002); Nollet LML *Handbook of Food Analysis: Residues and Other Food Component Analysis*, p. 835, CRC Press (2004).

6. See, for instance, the discussion in Zlesak, D "Variability in color expression" *Rose Hybridizers Association Newsletter* 33 4 15 (2002).
7. Pigment compositions of cultivars not mentioned by Eugster and otherwise uncited are from:
 - a. Yokoi M, "Relation of Quantitative Flower Colour Measurement to the Flower Colour in Rose Cultivars" *The Technical Bulletin of Faculty of Horticulture, Chiba University* 26 1 (1979) . Downloaded November 10, 2008 from <http://ci.nii.ac.jp/naid/110004699677/>. For the list of cultivars and their pigment compositions extracted from this paper see <http://spreadsheets.google.com/ccc?key=pRp5DasGnb87Jp-F8PlW7eA&hl=en>.,
 - b. Marshall, HH, "Anthocyanin Pigments in Roses" Pamphlet listing gross composition of anthocyanin pigments for about 100 roses. Published privately and once held by the RHA Lending Library. See http://docs.google.com/View?docid=df7wv2dn_0fxhc99z7.
8. For a discussion of the ancestry of modern roses see my upcoming article "Fun with Numbers" to be published in the Spring, 2009 RHA Newsletter.
9. Yukihiisa Katsumoto et al. "Engineering of the Rose Flavonoid Biosynthetic Pathway Successfully Generated Blue-Hued Flowers Accumulating Delphinidin". *Plant and Cell Physiology* 48 11 1589-1600 (2007).
10. Zary, K. personal communication. A second generation of engineered roses is currently being tested. These have an increased number of copies of 3'5' hydroxylase gene, which adds the third OH group to the anthocyanin molecule, in an effort to supersaturate the cellular vacuoles that contain the pigments. Suntory engineers are also attempting to address cellular pH issues but so far have not been successful.
11. Fukui,Y, et al. "Two novel blue pigments with ellagitannin moiety, rosacyanins A1 and A2, isolated from the petals of *Rosa hybrida*". *Tetrahedron* 62 9661–9670 (2006).
12. Fukui Y, personal communication.
13. Shiono M et al. "Phytochemistry: Structure of the blue cornflower pigment". *Nature* 436, 791 (11 August 2005). See the news article at <http://www.independent.co.uk/news/science/why-cornflower-blue-is-like-a-red-red-rose-502365.html>, downloaded December 18, 2008.
14. Eugster, C. H. Rosenfarbstoffe aus der Sicht eines Chemikers. *Rosa Helvetica* p.25 (1988/89).
15.
 - a. Harkness, Peter, Modern Roses. Century Hutchinson Ltd. p.17 (1987).
 - b. Francis Meilland later used **Capucine Chambard** as his own "Soleil d'Or and this lineage has brought yellow to about 10% of modern roses, most of which also have Soleil d'Or in their ancestry.
16. "Abscissic Acid". *Wikipedia*. http://en.wikipedia.org/wiki/Abscissic_acid. Downloaded December 18, 2008.
17. Their daughter, also Marie, would eventually marry Joseph Pernet, scion of another rose breeding family in Lyon. It was this same Joseph Pernet who took the name Pernet-Ducher and gave us Soleil d'Or. The quest for strongly pigmented yellow roses was thus a family affair spanning generations.
18. See <http://www.rosehybridizers.org/forum/message.php?topid=18449#18449> downloaded December 18, 2008.
19. Rodriquez E, personal communication.
20. See various articles republished in the *Rose Hybridizers Association Newsletter*, 33 4 (2002).
21. Perry, J. Personal communication.
22. However, certain of the green carotenoid pigments give green apples their color, and their existence in roses leaves open the possibility of breeding a true green rose!
23. A download of the chart is available from <http://holeman.org/Dons%20Handy%20Rose%20Pigment%20Color%20Chart.pdf>.
24. Colors of the pigments swatches are the RGB complement of the corresponding peak absorption wavelength. RGB conversion was made using software by Miguel Moreno downloaded October 30, 2008 from <http://miguelmoreno.net/sandbox/wavelengthtoRGB/default.aspx>. The software employs an heuristic algorithm developed by Dan Burton, see <http://www.midnightkite.com/color.html>.