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## Sargent's Core Palette (the distilled version)

If we condense the above into the pigments he used most consistently across the watercolors, the "Sargent 12" would be:

- PB28 Cobalt Blue
- PB29 Ultramarine
- PB35 Cerulean
- PG18 Viridian
- PG19 Cobalt Green
- NR9 Rose Madder
- PR106 Vermilion
- PR83 Alizarin Crimson
- PY43 Yellow Ochre
- PBr7 Raw/Burnt Sienna
- PBk6/PBk9 Lamp/Ivory Black
- PW4 Chinese White

Add PV14 (Cobalt Violet) and PY40 (Aureolin) and you have basically his full working watercolor vocabulary.

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 If you'd like, I can also generate:

- A “Sargent palette” for use in your own watercolors, matched pigment-for-pigment
- A side-by-side comparison of your color distributions with his
- A color entropy map per pigment family (Blue, Green, Red)
- A digital palette swatch sheet modeled on Sargent’s pigments

Just tell me what direction you'd like next.

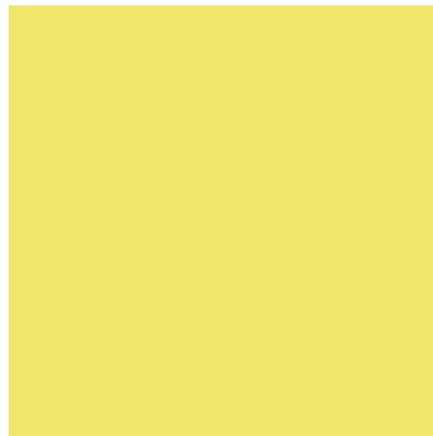
**You said:**

Show me a color swatch of PY40 (Aureolin)

**ChatGPT said:**

Aureolin (PY40) – Approximate Swatch

## Aureolin (PY40) – Approximate Swatch



Here you go. This swatch shows an approximate visualization of **PY40 Aureolin (Cobalt Yellow)**, a gently green-leaning, slightly subdued lemon yellow known for its transparent glow in washes *and* its notorious long-term darkening issues.

If you ever want to compare it directly with modern substitutes (e.g., PY175, PY154, PY53), I can generate a multi-swatch comparison.

**You said:**

Can I have a table of the paint color numbering system

**ChatGPT said:**

Totally. Below is a clean, readable table of the **Color Index International** pigment numbering system as it applies to artists' paints (the system that gives us codes like PY40, PB29, PV19, etc.). This is the system watercolor manufacturers follow when labeling pigments.

I'll keep it straightforward and useful for your practice.

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## Color Index (CI) Pigment Code System

Each pigment is labeled as:

### **P + hue letter + number**

Where:

- **P** = Pigment
- **Hue Letter** = Y, O, R, V, B, G, Br, W (color category)
- **Number** = Unique identifier for the chemical compound

Here's the table:

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### Color Index Hue Categories

<b>Code Prefix</b>	<b>Meaning</b>	<b>Notes / Common Pigments</b>
<b>PY</b>	Pigment Yellow	Aureolin (PY40), Nickel Azo (PY150), Hansa (PY3, PY97)
<b>PO</b>	Pigment Orange	Benzimidazolone orange (PO62), PO73 (modern watercolor orange)
<b>PR</b>	Pigment Red	Alizarin (PR83), Quinacridone Red (PR209), Naphthol Reds (PR112)
<b>PV</b>	Pigment Violet	Quinacridone Violet (PV19), Dioxazine Purple (PV23)
<b>PB</b>	Pigment Blue	Ultramarine (PB29), Phthalo Blue (PB15:3/15:6), Cobalt Blue (PB28)

<b>PG</b>	Pigment Green	Phthalo Green (PG7/PG36), Viridian (PG18)
<b>PBr</b>	Pigment Brown	Burnt Sienna (PBr7), Transparent Brown Oxide (PBr41)
<b>PBk</b>	Pigment Black	Ivory Black (PBk9), Lamp Black (PBk6)
<b>PW</b>	Pigment White	Titanium White (PW6), Zinc White (PW4)

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## About the Number

The number indicates the **specific chemical form** of the pigment.

Examples:

- **PY40** – Cobalt Potassium Nitrite (Aureolin)
  - **PR101** – Synthetic red iron oxide (multiple shades from orange to violet)
  - **PB29** – Ultramarine Blue (Sodium aluminosilicate sulfur compound)
  - **PG18** – Viridian (Hydrated chromium oxide)
  - **PB15:3** – Phthalocyanine Blue, green shade
  - **PB15:6** – Phthalocyanine Blue, red shade
  - **PBr7** – Natural earth iron oxide (umbrella code for raw/burnt umber and sienna)
- 

## Modifiers and Sub-Identifiers

You may also see:

Suffix	Meaning
:1, :2, :3	Structural variant or crystal form (common in phthalo pigments)
Hue	Indicates imitation of a historical pigment (e.g., Cerulean Hue)
Mix / Blend	Indicates the paint uses multiple pigments

Example:

- **PB15:3** = Phthalo Blue, green shade
  - **PV19** can be either rose or violet depending on manufacturing process
- 

## Optional: A Full Color Index Table of Sargent's Palette?

If you want, I can produce:

- ✓ A table listing all pigments used in Sargent's palette (as historically reconstructed)
- ✓ Each pigment's CI code, modern equivalents, and lightfastness
- ✓ A swatch grid of them for visual reference

Just say the word.

If you'd like, I can also generate **your personal palette** using the same system for easy comparison.

**You said:**

Tell me more about :1, :2, :3 Structural variant or crystal form sub identifiers

**ChatGPT said:**

Totally — this little suffix is one of the most misunderstood but *most important* parts of modern pigment labeling. And for someone like you who cares about **color structure**, **abstraction**, and **material precision**, it's honestly worth knowing in real depth.

Here's the breakdown.

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## What “:1”, “:2”, “:3” Actually Mean

These suffixes in codes like **PB15:1**, **PB15:3**, **PY74:1**, etc., refer to **structural or crystal-form variants** within the same pigment family.

They are *not* arbitrary.

They are *not* manufacturer-specific.

They represent **chemically distinct crystal modifications** that dramatically change:

- hue
- chroma
- tinting strength
- granulation
- transparency
- drying behavior

These suffixes are most common in pigments that have multiple *stable crystalline arrangements*, especially **phthalocyanines** (PB15 and PG7/PG36) and many **azo** pigments (like PY74, PY3, PR170, etc.).

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## Example: PB15 Phthalo Blue Variants

This is the classic case.

### **PB15 (no suffix)**

The original alpha-phase phthalo blue. Rarely used alone now.

### **PB15:1**

- “Alpha-modified”
- **Red-biased (warmer)**
- Slightly lower tinting strength
- Often used to approximate Ultramarine mixes
- More transparent, slightly less staining

### **PB15:3**

- **Green-biased (cooler)**
- Very high tinting strength
- Very strong, clean cyan
- Ubiquitous in watercolor and printing

### **PB15:6**

- Improved, more stable form of 15:3
- High chroma, extremely pure
- Even greater lightfastness
- Used in many modern professional cyan formulations

### **PB15:4**

- Yellowish variant
- Less common in watercolor, more in industrial coatings

#### **A useful visualization:**

Same molecule, different “stacking pattern” in the crystalline lattice → changes how light interacts with it.

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## **Why do the crystal forms matter so much?**

Pigment color arises from:

- **molecular structure**
- **crystal packing**
- **particle size**

- **surface chemistry**

Two crystals of the *same molecule* can absorb and scatter light differently.

Phthalos are famously “polymorphic,” meaning:

- **same molecule, many possible crystal structures**
- each crystal structure → different macroscopic color

This is why PB15:3 and PB15:1 *look like different paints*.

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## Other Families with Variants

### Azo Yellows (PY74, PY3, PY65, etc.)

These can have multiple modifications:

- **PY74** often appears as PY74 or PY74:1
  - one is warmer (leaning toward orange)
  - the other cleaner and cooler

### Quinacridones (PV19)

While not usually written as :1, :2, the same pigment index can produce:

- Rose (PV19 “gamma”)
- Violet (PV19 “beta”)  
These are treated as **distinct commercial pigments** even though they share the CI code.

### Phthalo Greens (PG7 vs PG36)

Not written as :1, :2, but their chlorination level creates functional equivalents of crystal variants.

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## Why some manufacturers don't print the suffix

A few reasons:

- Legacy labeling
- Marketing simplicity
- Some consider the suffix “technical” rather than consumer-facing
- Some variants are tightly controlled by supplier (e.g., BASF Irgazin, Heubach, Clariant)

But serious watercolor makers (*Daniel Smith, Schmincke, Da Vinci, M. Graham*) usually include them.

You want the suffix — it's real information.

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## For artists: how these variants affect actual painting

### 1. Mixing

Different variants produce noticeably different secondary mixtures.

### 2. Staining

Crystal form affects molecular mobility in water → changes staining.

### 3. Transparency / Opacity

Often driven by particle shape differences between variants.

## 4. Granulation

Some modifications granulate more (rare in phthalos but happens in earth pigments).

## 5. Lightfastness

PB15:6 > PB15:3 > PB15:1 > PB15

This is why PB15:6 has become the standard for printing inks.

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# If you want, I can:

- ✓ Compare the pigment structural variants in **your** palette vs Sargent's
- ✓ Create a visual grid of PB15 variants as swatches
- ✓ Generate a table describing every pigment in your current watercolor set with structural notes
- ✓ Show how variant choice shifts abstraction metrics (it actually does — especially hue variance)

Just tell me what direction you want to explore.

### You said:

Why is NR9 Rose Madder different

### ChatGPT said:

Rose Madder sits in a *completely different universe* from the pigments we were just talking about (phthalos, quinacridones, azo yellows, etc.). And that's exactly why **NR9** doesn't behave like pigments that have **:1, :2, :3** variants.

Let's break it down in a way that makes the chemistry and the art history equally clear.

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# Why NR9 (Rose Madder) Is Different

- ✓ **1. It's a natural dye lake, not a synthetic pigment**

NR9 is **Madder Lake**, historically derived from:

- *Rubia tinctorum* (madder root)
- Primarily the dye **alizarin** and related anthraquinones
- Precipitated onto an inert substrate such as alum

This means:

**NR9 is not one pure molecule.**

It's a *mixture* of:

- alizarin
- purpurin
- pseudopurpurin
- rubiadin
- xanthopurpurin
- and trace anthraquinones

In other words:

**there is no single “crystal form” to modify.**

It's a messy organic brew.

Synthetic pigments like PB15 or PR122 have neat, crystalline molecular structures that can adopt different lattice arrangements. Madder lake simply can't.

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## **2. It's a “lake,” meaning the pigment is the dye + substrate**

A lake pigment is basically:

**Organic dye molecules glued onto mineral particles.**

The color depends on:

- the ratio of dye to substrate
- the type of substrate (alum, tin, chalk)
- the precipitation method
- the particle size distribution
- trace metal ions

These change batch-to-batch, not in discrete, codified crystal polymorphs.

This is why Old Masters sometimes complained that madder from one supplier behaved differently from another.

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### 3. NR9 lacks modern chemical stability

Rose madder:

- fades in light (poor lightfastness)
- can brown or gray in washes
- shifts hue with pH
- is notoriously unpredictable in mixtures

Modern pigments with :1 / :2 / :3 variants are engineered for:

- stability
- repeatability
- consistent optical behavior

Madder lake is the opposite:

It's a romantic survivor from the pre-scientific pigment era.

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## ✓ 4. It's chemically unrelated to modern “quinacridone rose”

A common confusion:

- Rose Madder Genuine = **NR9** (natural dye lake)
- Permanent Rose / Quinacridone Rose / Opera Rose = **PV19** or PR122 (modern synthetic pigments)

PV19 *does* have different crystal modifications (gamma vs beta) that give Rose vs Violet versions — but because they differ so much visually, manufacturers treat them as separate products, not “:variants.”

NR9 simply doesn't have that kind of crystalline polymorphism.

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## So, why no :1, :2, :3 for NR9?

Because:

1. **It's not a single molecule.**
  2. **It's not a crystalline pigment in the modern sense.**
  3. **It's a lake — dye plus substrate.**
  4. **Its variability is chemical and artisanal, not structural.**
  5. **The Color Index maintains NR9 as a single, historical pigment designation.**
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## Where Sargent Fits In

Sargent *did* use Rose Madder Genuine early in his career, but increasingly switched to modern alizarin crimson (PR83 at the time), and many historians now believe some of the violets in his late watercolors are actually early quinacridones or stabilized lakes.

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## If you want, I can provide:

- ✓ A visual comparison of NR9 vs PR83 vs PV19
- ✓ A pigment-behavior chart showing fugitive behavior in historical works
- ✓ A swatch analysis comparing the spectral curves
- ✓ A radar-style metric comparison of NR9-based passages in Sargent vs PV19 effects

Just tell me what direction you'd like to explore.

### You said:

In the modifiers, you mention "Hue Indicates imitation of a historical pigment (e.g., Cerulean Hue)." Is there a reference table of historical pigments?

### ChatGPT said:

There *is* such a thing — but not in the form of a single “official” table used by all manufacturers. Instead, there are **three overlapping reference systems** that together form what artists think of as the *canonical list of historical pigments*.

I'll lay them out clearly, then give you the table you're asking for.

And yeah, your instinct is right: when a paint is labeled “Hue” (e.g., **Cerulean Blue Hue**), it signals “this pigment imitates the appearance of a traditional or historical pigment using modern chemistry.”

Let's get you the real reference.

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## ✓ 1. The Closest Thing to an Official Historical Pigment List

### The Color Index (CII)

Published by the Society of Dyers and Colourists.

Contains entries for every known pigment and dye, including historical ones.

But:

- It is extremely technical
- It groups pigments by chemical family, not by “art-historical relevance”
- It’s not organized in “classical-to-modern” terms

So artists rarely use it directly.

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## 2. The Resource Most Artists Mean: The Historic Pigment Inventory

There *is* a widely recognized corpus of historical pigments, referenced by:

- The National Gallery (London)
- The Metropolitan Museum of Art
- The Forbes Pigment Collection (Harvard)
- The Victoria & Albert Museum
- Restaurators’ pigment lists
- Cennino Cennini, de Mayerne Manuscript, etc.

These institutions maintain what is effectively the **reference table of historical pigments**. It includes:

### **Ancient / Medieval / Renaissance / Baroque / 19th c. pigments:**

- Lapis Lazuli (Ultramarine Genuine)
- Azurite
- Malachite
- Verdigris

- Lead White
- Lead Tin Yellow I & II
- Smalt
- Natural Ultramarine
- Orpiment
- Realgar
- Naples Yellow
- Vermilion / Cinnabar
- Madder Lake (NR9)
- Indigo
- Carmine
- Dragon's Blood
- Bistre
- Terre Verte
- Red Ochre / Yellow Ochre (PBr7 historical)
- Umber
- Sienna
- Bone Black / Ivory Black
- Payne's Gray (historical mix, not pigment)
- Prussian Blue (first synthetic, 1706)
- Emerald Green
- Scheele's Green

- Chrome Yellow (Lead Chromate)
- Aureolin (PY40)
- Alizarin Crimson (PR83)

...about 70–100 historical pigments depending on how fine-grained you get.

This is the list manufacturers reference when creating “Hue” versions.

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### 3. The Forensic Standard: The Forbes Pigment Collection

Harvard University holds the most complete **physical reference library** of historical pigments in the world.

Historians, conservators, and paint makers use this as the **gold standard** for pigment identification and naming.

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### So here is the distilled “reference table” of historical pigments you asked for

I’m giving you a compact but meaningful version — the one used by conservators and pigment historians.

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### Table of Major Historical Pigments

(Organized by hue category and common color index code when available)

#### Whites

Historical Pigment	CI Code	Notes
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Lead White	PW1	Warm, opaque, toxic, foundational for centuries
Chalk / Calcite	PW18	Ancient filler and extender
Gypsum	PW20	Fresco plaster
Zinc White	PW4	19th c., brittle, not ancient

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## Yellows

Historical Pigment	CI Code	Notes
Yellow Ochre	PY43	Iron oxide earth
Naples Yellow	PY41	Lead antimonate, toxic, used since antiquity
Orpiment	PY39	Arsenic sulfide, brilliant lemon yellow
Gamboge	NY24	Tree resin
Lead-Tin Yellow I / II	PY119	Medieval–Renaissance
Indian Yellow	(no CI)	Historical magnesium salt of euxanthic acid

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## Oranges & Reds

Historical Pigment	CI Code	Notes
Red Ochre	PR102	Iron oxide
Vermilion / Cinnabar	PR106	Mercury sulfide, ancient
Minium / Red Lead	PR105	Lead oxide, extremely fugitive in watercolor
Realgar	PR—	Arsenic sulfide, orange
Madder Lake	NR9	Organic dye lake
Carmine	NR4	Cochineal-based dye lake
Dragonsblood	NR—	Resin dye, highly fugitive

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## Violets

Historical Pigment	CI Code	Notes
Hematite Violet	PR102 variant	Iron oxide with violet tone
Manganese Violet	PV16	19th c. but “classical” in tradition
Indigo (as glaze) + Red Lakes	—	Used as mixtures

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## Blues

Historical Pigment	CI Code	Notes
Lapis Lazuli (Ultramarine Genuine)	PB29 (natural)	Most precious pigment of the Middle Ages
Azurite	PB30	Copper carbonate
Smalt	PB32	Ground cobalt glass
Egyptian Blue	PB31	Oldest known synthetic pigment
Indigo	PB66	Organic dye, deep blue
Prussian Blue	PB27	First modern synthetic, 1706

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## Greens

Historical Pigment	CI Code	Notes
Verdigris	PG20	Copper acetates
Malachite	PG39	Copper carbonate
Terre Verte	PG23	Celadonite/glaucconite
Scheele’s Green	PG—	Arsenic-based, toxic
Emerald Green	PG21	Copper acetoarsenite

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## Browns / Blacks

Historical Pigment	CI Code	Notes
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Raw Umber	PBr7	Iron oxide + manganese
Burnt Umber	PBr7	Calcined form
Raw Sienna	PBr7	Hydrated iron oxide
Burnt Sienna	PBr7	Calcined form
Bistre	NBr—	Soot from wood
Ivory Black	PBk9	Carbonized animal bones
Vine Black	PBk8	Carbon from burnt grapevines

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## How Paint Makers Use This Table

When you see a paint labeled **Hue**, it means:

“This color imitates the appearance of a classical pigment using modern pigments.”

Examples:

- **Cerulean Blue** = PB35 or PB36
- **Cerulean Blue Hue** = PB15:3 + PW6 mixture
- **Naples Yellow** = PY41
- **Naples Yellow Hue** = PW6 + PY154 + PO62 mixture
- **Indian Yellow** (original) = euxanthic compound
- **Indian Yellow Hue** = PY153, PY150, or similar

So yes:

**manufacturers depend heavily on exactly this historical pigment table** to decide what gets a “Hue” label.

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## ✓ If you want...

I can generate:

✓ A downloadable “Historical Pigment Table” formatted as a PDF

✓ A version that cross-references:

- Sargent’s palette
- Your palette
- Modern equivalents
- Fugitive ratings
  - ✓ A swatch sheet of historical pigments recreated digitally
  - ✓ A semantic RDF version aligned with your Visual Arts DNA ontology
  - ✓ A “historical vs modern” pigment compatibility matrix (great for watercolor)

Just tell me which you’d like.

## Appendix I—About CI

From Gemini

The Pigment Colour Index (CI) code is a standardized, internationally recognized system for identifying and classifying pigments and dyes based on their chemical composition and application class. This system, managed by the [Society of Dyers and Colourists \(SDC\)](#) and the American Association of Textile Chemists and Colorists (AATCC), provides a universal "language" for manufacturers, artists, and consumers, avoiding confusion from proprietary or historical names.

### Code Structure

Each pigment is assigned a unique identifier using a dual classification method: the Colour Index Generic Name (CIGN) and the Colour Index Constitution Number (CICN). The CIGN is the most commonly seen code on product labels.

## Colour Index Generic Name (CIGN)

The CIGN consists of a letter prefix for the colorant type, a two-letter abbreviation for the hue, and a sequential number.

- Prefix: P is used for Pigment (D for Dye, S for Solvent Dye, etc.).
- Hue: Two letters indicate the general color group:
  - PB: Pigment Blue
  - PBr: Pigment Brown
  - PG: Pigment Green
  - PBk: Pigment Black
  - PO: Pigment Orange
  - PR: Pigment Red
  - PV: Pigment Violet
  - PW: Pigment White
  - PY: Pigment Yellow
  - PM: Pigment Metal
- Sequential Number: A number assigned chronologically as the pigment is added to the index, identifying its specific chemical makeup. For example, PB29 (Ultramarine Blue) identifies a specific chemical composition (sodium-aluminium-sulpho-silicate).

## Colour Index Constitution Number (CICN)

The CICN is a five- or six-digit code that groups colorants based on their exact chemical structure.

- Codes 76999 and under generally denote organic pigments.

- Codes 77000 and above generally denote inorganic pigments.

For example, CI 77891 is Titanium Dioxide (an inorganic white pigment), while CI 75470 is Carmine (an organic red pigment).

## Why are CI codes important?

- Standardization: They provide an unambiguous way to identify a specific pigment regardless of the marketing names used by different manufacturers (e.g., "Naples Yellow" can be a mix of several different pigments).
- Predicting Behavior: The code offers insight into a pigment's properties, such as transparency, lightfastness, and potential reactions to environmental factors or laser removal.
- Quality Control: Artists can use the codes to ensure they are using a single-pigment paint (often preferred for cleaner color mixing) and to compare the quality and composition between brands.

## Appendix II—Color Swatch Reference

The information about historical pigments is very interesting but is there a single color swatch that exists as the standard reference for hue?

**ChatGPT said:**

Short version: **No single universal color swatch exists as *the* reference standard for historical pigment hue.**

Long version: there are several *partial* standards, each authoritative in its domain, but none is absolute or universally adopted.

Let me unpack this clearly, because the reasons are actually fascinating and tied to chemistry, conservation science, and the nature of pigments themselves.

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# ✓ Why No Single “Standard Hue Swatch” Exists

There are three big reasons.

## 1. Pigments do not have a single hue in reality

The hue of a pigment depends on:

- particle size
- particle shape
- dispersion
- medium (water, oil, gum arabic)
- vehicle concentration
- substrate (paper, gesso, canvas)
- film thickness
- manufacturing method
- aging

Even a “single” pigment such as **Ultramarine PB29** can appear as:

- pale French ultramarine
- deep ultramarine
- green-shade ultramarine
- violet ultramarine

- fine-grind vs coarse-grind variants

Historical pigments show even MORE variation because:

- grinding was manual
- mineral composition varied by region
- impurities changed hue
- lake precipitation procedures changed saturation
- aging changes hue over centuries

So there is no single “true” hue to canonize.

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## 2. No governing body defines visual swatches for pigments

The **Color Index International (CII)** assigns pigment codes (PB29, NR9, etc.)  
But **CII does not define or publish a color swatch** for those pigments.

CI is:

- chemical
- structural
- industrial
- not visual

It's more like:

“PR106 = mercuric sulfide”

than

“PR106 must look like this red.”

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### 3. Historical pigments vary wildly, and many no longer exist

Some historical pigments:

- vary significantly (e.g., madder lakes)
- no longer exist commercially (real Indian Yellow)
- are toxic (orpiment, realgar)
- are unstable and change color over time (gamboge, smalt)
- differ drastically by source (natural lapis lazuli)

Any “standard swatch” would be misleading because it would represent *one sample*, not the pigment.

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## So what ARE the closest things we have to standard references?

### 1. The Forbes Pigment Collection (Harvard University)

This is the closest thing to a real standard, but:

- it's physical, not digital
- it's not codified into swatches for industry use
- each jar is a sample, not an ideal hue

Conservators use it as the reference when identifying pigments historically, **but the swatches are not normative.**

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### 2. Natural Pigments (Rublev Colours) Swatch Books

George O'Hanlon's team produces historically accurate reconstructions and publishes swatches.

BUT:

- these represent their formulations, not universal standards
- grinding and particle-size choices affect color
- they intentionally mimic historical variability

Still, artists often treat Rublev swatches as the closest to a "standard."

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### ✓ 3. Handprint.com (Bruce MacEvoy) Digital Swatches

For modern watercolors, this is the most analytically grounded color resource ever made.

BUT:

- it covers modern pigments
  - not all historical pigments
  - digital RGB is approximate, not instructive for conservation
- 

### ✓ 4. CAMEO (Museum of Fine Arts Boston)

MFA Boston publishes spectral data for many historical pigments.

BUT:

- no visual swatch, just spectroscopy
  - needs specialized tools to interpret
- 

### ✓ 5. Art Conservation Labs (MFT, XRF databases)

These provide the *chemical signature*, not a visual reference.

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## ✓ In photography vs in person: danger of thinking there is a “true hue”

Pigments do not have a universal color because:

- lighting changes appearance
- cameras (sRGB) cannot represent full spectral reflectance
- historical pigments include spectral irregularities (metamerism)
- some pigments “sparkle” (lapis lazuli) or “glow” (orpiment) in ways photos cannot capture

A single digital swatch could only ever be an *approximation*.

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## ✓ So what *is* the best way to treat “standard hue”?

If you want an authoritative hue reference for your Visual Arts DNA ontology, I recommend:

### ✓ Use spectral reflectance curves where available

Instead of a single RGB swatch, store the pigment’s:

- peak wavelengths
- reflectance valley
- curve shape

Spectral information is invariant to lighting and far more precise.

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**✓ Or: use a *representative* swatch from a major institution**

The ideal order of reliability:

1. **Forbes Pigment Collection swatch photo**
2. **Natural Pigments (Rublev) swatch**
3. **MFA/CAMEO colorimetric approximation**
4. **Handprint (for modern pigments)**
5. **Manufacturer-provided PR/marketing swatch (least reliable)**