Stanford University meets the wax collections at La Specola

Introduction

Stanford is a small University (7500 undergraduate and 9000 graduate students) in Silicon Valley, California, with several satellite campuses in countries around the world. One of the major campuses is in Florence and is a five-minute bicycle ride from La Specola. Stanford, a leader in the use of technology in education, has been the perfect place to experiment with methods of integrating the anatomical wax collection of La Specola into the college curriculum.

In this world of advanced digital imaging technology, the anatomical wax collection has yet to reach its full potential as a teaching tool. The use of computers in imaging allows us to capture three-dimensional interactive images of these spectacular 200-year-old waxes, and while originally these waxes were sculpted for medical students and the public in Italy, now with this new technology, the images could be accessible to anyone with an iPhone or a computer.

The waxes were first introduced to Stanford by Dr Robert Chase, a surgeon and anatomist, who was stationed in Italy during the second world war. After the war, he moved to California where eventually he became the chief of the Department of Surgery at Stanford in addition to being the Chairman of the Division of Anatomy in the School of Medicine. In 1998 Chase introduced me to the Italian waxes through his own small photographic series and his collection of illustrated books. I was staggered by their compelling beauty. Not only are they works of art, but they are both anatomically accurate and color accurate. Some of the wax colors, while slightly faded are far superior to the colors of an embalmed cadaver and, quite similar to the colors of a dissected fresh cadaver.

The Specola wax collection today hosts 65 comparative anatomy cases and 513 human anatomy cases – 26 of which present the whole body. One figure, 'Venus', an aesthetically beautiful and technically impressive model consists of several layered segments. It is possible to manually remove each of the layered pieces to closely examine multiple internal organs, including the valves of the heart and the uterus containing a fetus. The model is a masterpiece of wax sculpturing. Another set of waxes explores the perceived development of the child in the womb. The waxes are 3-dimensional and are spectacularly useful for conveying the spatial relationships of the anatomical structures. Traditionally, anatomical texts are restricted to 2-dimensional drawings, photographs, and x-rays of the human body. These ancient anatomical waxes portray the true 3-dimensional body in captivating detail.

Capturing the images

In 2015 I received permission from Claudia Corti, the Chief Curator of the wax collection at La Specola in Florence, to photograph 200 of the sculptures. I was also awarded a grant from Stanford University to complete this work. Ron Labbe, from Maynard, MA, one of America's finest stereo photographers, was hired and together, with Dr Corti and Saulo Bambi, La

Specola's photographer, we spent considerable time collecting a set of high-resolution stereo photographs.

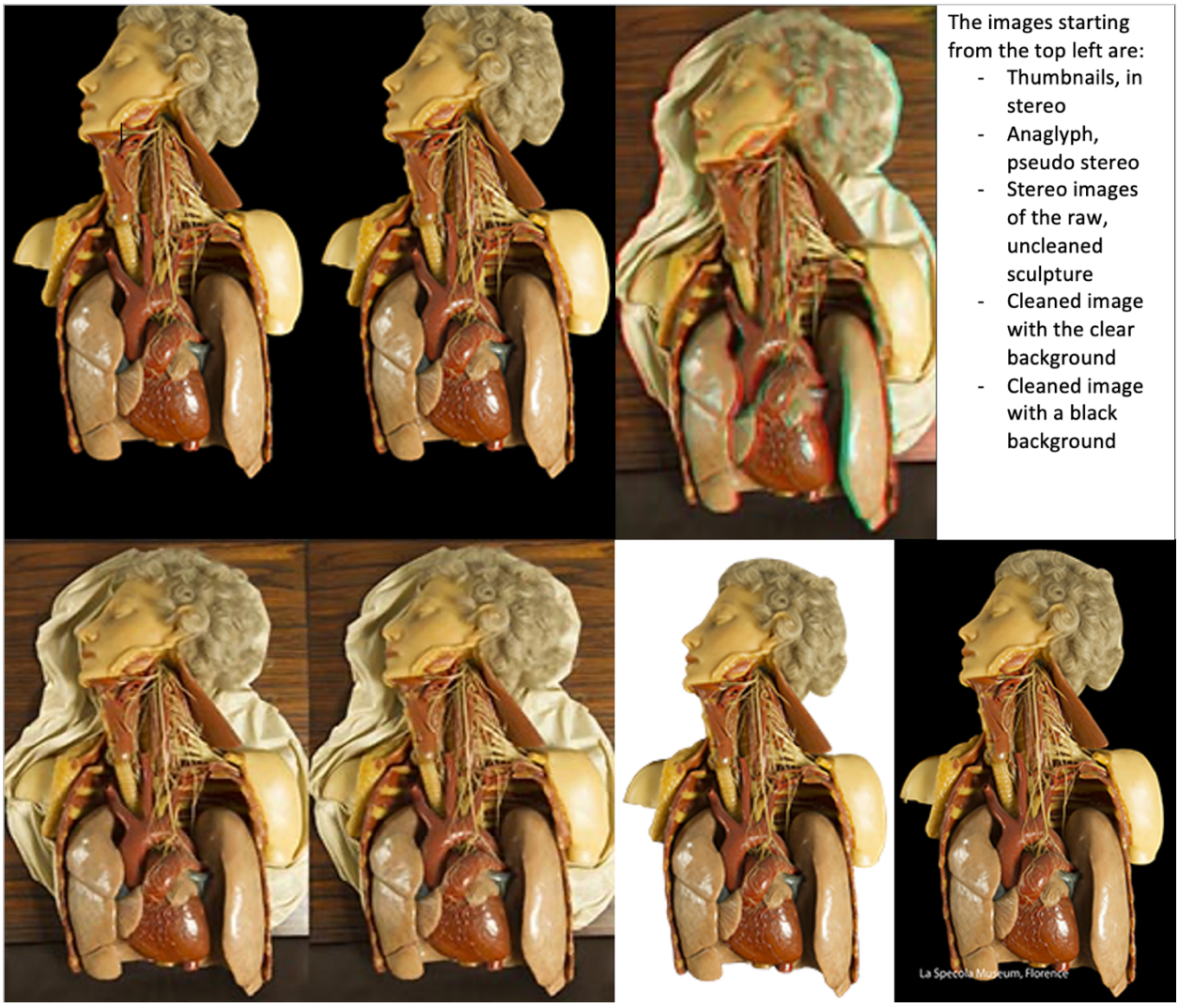
Stereo imaging (3D) requires two images of a subject, one for each eye. The amount of parallax, or difference between the images, can be carefully controlled during photography for optimum perception of depth. Normally these images are viewed with a stereoscopic viewing device, but glasses-free screens are currently available for viewing these stunning dimensional photographs.

Following the acquisition of the photographs the images were sent to Arbisoft, in Pakistan, a software development company directed by Yasser Bashir, a former Stanford computer science graduate, for processing and cleaning. For each photograph the cloth backgrounds of the museum display cases were removed, and a thumbnail image was produced.

Each anatomical sculpture in our collection included:

- a thumbnail image,
- an anaglyph stereoscopic 3-D image,
- a High-resolution untouched image (with the museum cloth behind the wax)
- a Low-resolution untouched image (with the museum cloth behind the wax)
- a High-resolution cleaned image (which includes only the wax sculpture)
- a Low-resolution cleaned image (which includes only the wax sculpture)
- some Photogrammetry scanned models for viewing in 3-D interactive programs, such as the Anatomage Virtual Dissection Table, and handheld devices using applications, for example Polycam and ItSees3D.

Instructional use



The images starting from the top left are:

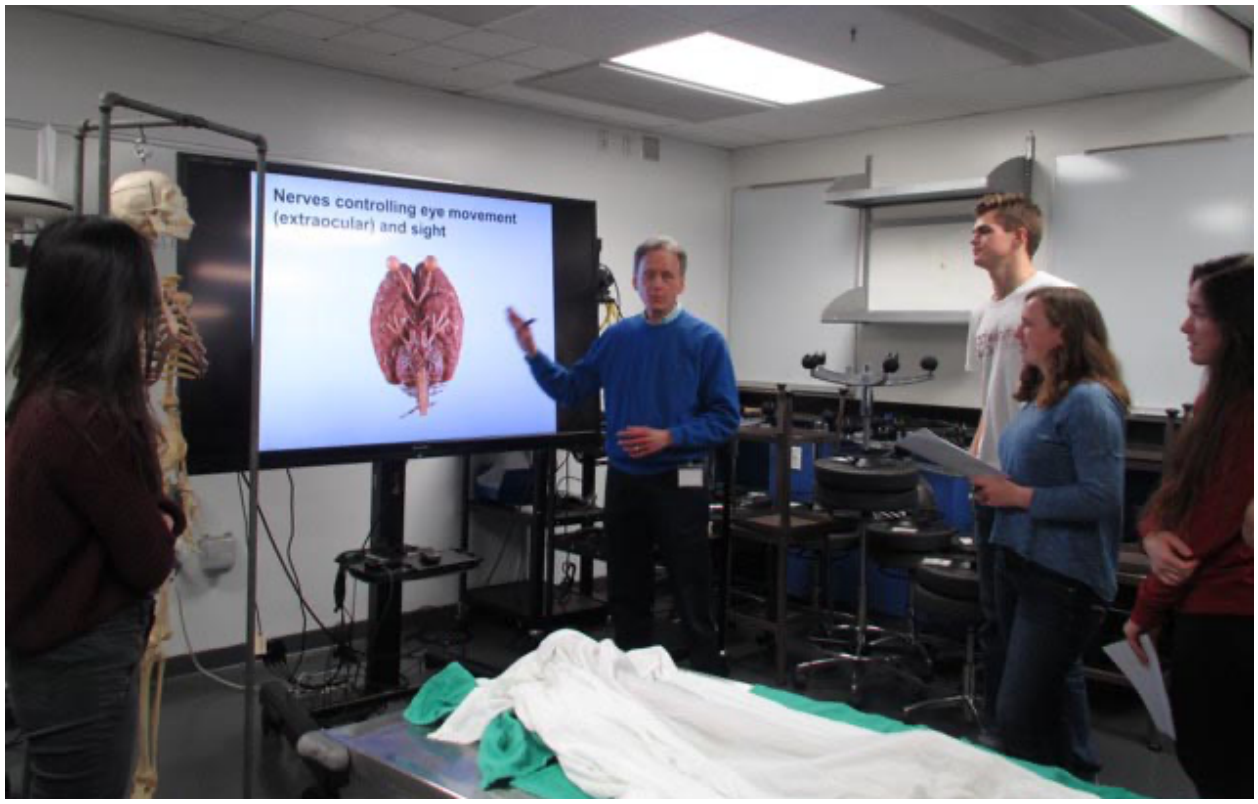
- Thumbnails, in stereo
- Anaglyph, pseudo stereo
- Stereo images of the raw, uncleaned sculpture
- Cleaned image with the clear background
- Cleaned image with a black background

The image above is a screen capture of 4 videos demonstrating the multiple viewing angles of the photogrammetry images.

The images, in all the forms illustrated above, were made accessible to any interested faculty in the Stanford School of Medicine and the associated Palo Alto Veterans Hospital. As a result, they showed up in lectures covering most medical specialties, including:
Anatomy, Neuroanatomy, Neurosurgery, Ophthalmology, General Surgery, Head & Neck Cancer and Reconstructive surgery, Anatomy for Bioengineers, and in courses such as: Anatomy and Design Innovations, and Anatomy and Society.
The images are also included in lectures to high school and junior college students. Visitors, both academic and public, who come to our offices in the Division of Clinical anatomy may also view the images.

The Image above is the cover page of an iBook on the History of La Specola and a virtual guided tour of the museum, authored by Dr. Alexandra Bourdillon,

Stanford University. It is available on Apple Books: [The Anatomical Wax Collection at La Specola on Apple Books]
The iBook discusses the origins of La Specola, the principals involved in the early funding, the early directors, and the structure that was built to house the collection. Two groups of workers were responsible for the creation of the waxes: the people that did the dissections were considered the real artists and the sculptures were regarded as only technicians. The iBook walks the reader through all the rooms of the museum. Each electronic page has a room description and multiple layers of some of the anatomical images in the room.



The above image shows Dr Bruce Fogel and some of his students using one of the brain images to illustrate the cranial nerves involved in eye movement. Dr Fogel, one of the principal users of the collection, teaches several courses in the Division of Clinical Anatomy which is under the umbrella of the Department of Surgery.

Within the Department of Surgery, there are several other courses using the images.For example, the Art & Anatomy Course Series includes: “Art and Anatomy Studio” geared to medical students, as well as “Anatomy for Artists”, and “Portraiture and Facial Anatomy for Artists,” which are open to medical, graduate, and undergraduate students. The course director, Lauren A. Toomer, is a lecturer at Stanford University in Department of Art & Art

History and in the Department of Surgery. She is also the Faculty Director of Visual Arts, Medicine & the Muse in Stanford University's School of Medicine. The short video included in "who we are" (https://www.youtube.com/watch?v=wqIN94PW6DI) references a class that demonstrates the wax models.

The above image is Toomer's Art & Anatomy class of Stanford medical students. She has similar classes for undergraduate students and, in addition provides classes for the general public, through Stanford's Continuing Studies program.

Although we try to make the images freely available inside Stanford, the red tape and the restrictions imposed by La Specola, Museo Di Storia Naturale are too restrictive to encourage their use. It is most unfortunate that the use of the images, even within Stanford, is so limited.

The wax sculptures are permanently housed at La Specola and they are seen by very few visitors. The Museum, currently closed, limits the number of visitors when it is open. The collection is so delicate that small vibration from foot traffic within the museum and even trucks passing on the street cause micro fractures of the wax and accelerate their deterioration. The beautiful linen and cushions that bed the collection are in constant need of repair. The

elaborate wooden and glass cases that cover each sculpture are beautiful but limit the viewing. The museum's precautions while unfortunate are necessary.

For studying and appreciating each individual sculpture, our high-resolution photographic images are far superior to viewing them in their glass boxes at the museum. Recent revolutions in digital imaging technology, such as photogrammetry, have paved the way for marvelous new tools for learning and studying the waxes in 3-dimensions. The waxes are sculpted in 3-dimensions and potentially can be viewed in 3-dimensions. New applications in 3-D computer graphics capability allow us to zoom, shift and twirl 3-D anatomical figures on computers, iPhones and other handheld devices and to determine our own, individual best viewing angles. Allowing viewers to individually establish their own key views of 3D models accelerates the understanding of the geography of the structures.

I have spent hundreds of hours with the sculptures and the images. It would have been impossible not to appreciate their extraordinary beauty, their importance, and their potential. I would propose applying to a Foundation for funding to photograph, using photogrammetry, the complete collection at the museum and to build a digital anatomical library. A digital library would preserve the museum's collection and could expose millions of students, academics, and the general public to these historic works of art.
In addition, if such a foundation, along with La Specola, would make this important resource available on an Open-Source platform the waxes could be accessed and studied globally.

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W. Paul Brown, DDS,FICD,FACD
PI, wpbrown@stanford.edu
Division of Clinical Anatomy
Dept of Surgery, Stanford University,
Stanford, CA 94305

Sakti Srivastiva, MD
Chair of the Division of Clinical Anatomy
Dept of Surgery, Stanford University

Ron Labbe
Stereoscopic Imaging Specialist
www.Studio3D.com
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CEO Arbisof
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Matthew Hasel
Program Consultant
Stanford University
Division of Clinical Anatomy

Miguel Angeles, MD
Lecturer
Stanford University
Division of Clinical Anatomy

Bruce Fogel, DDS,FICD,FACD
Adjunct Professor
Stanford University, Division of Clinical Anatomy
Dept of Surgery
Stanford, CA 94305

Lauren Toomer
lecturer, Stanford University,
Department of Art & Art History
Department of Surgery, Division of Clinical Anatomy

Graham Creasey, MD
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Stanford University

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Dr Claudia Corti
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Saulo Bambi
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Via Romana, 17 – 50125 Firenze

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Stanford University

Giovanni Pratesi
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Via G. La Pira, 4 – 50121 Firenze

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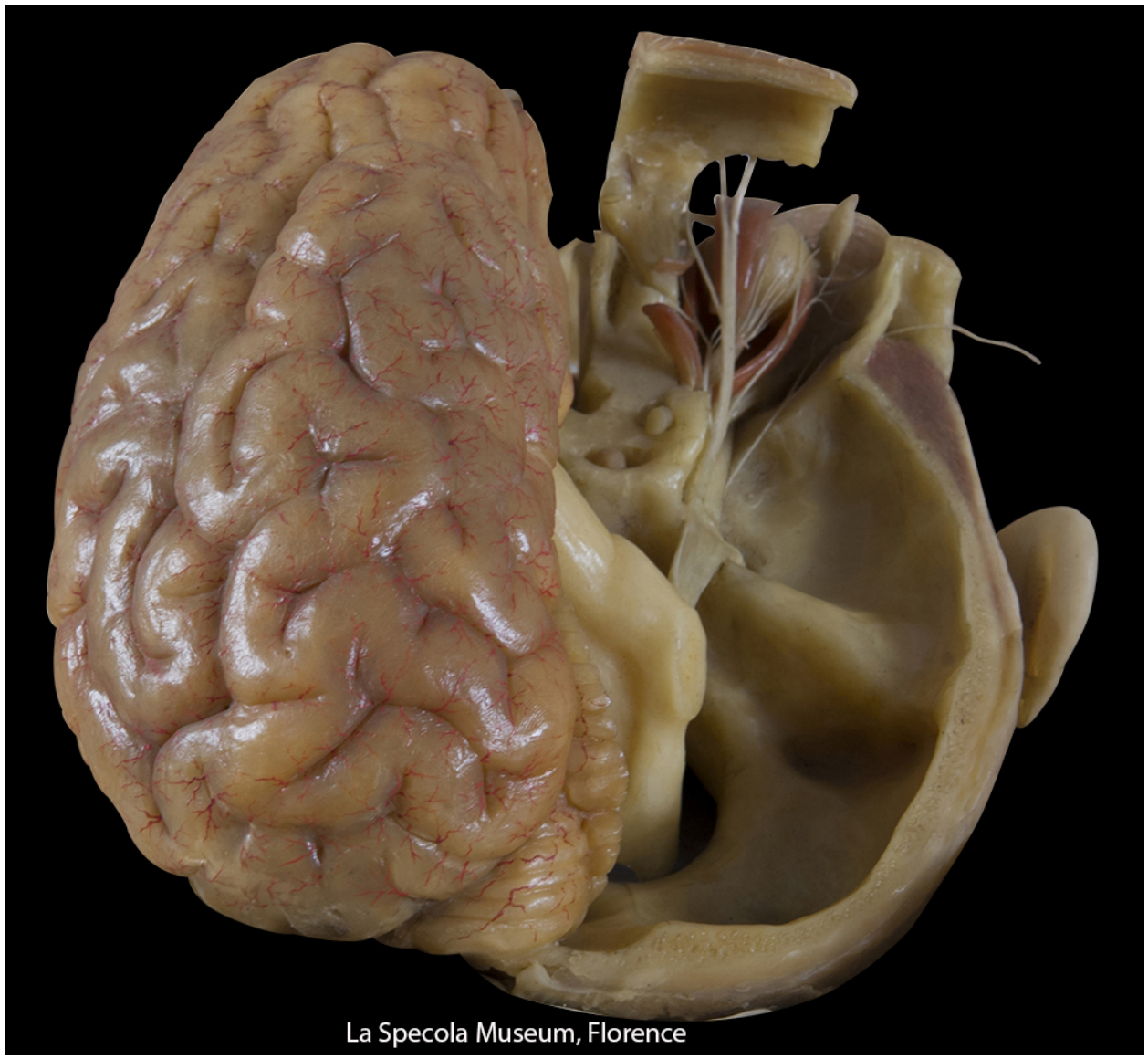
Department of Experimental & Clinical Medicine
Section of Anatomy & Histology
Universita Delgi Studi-Frienze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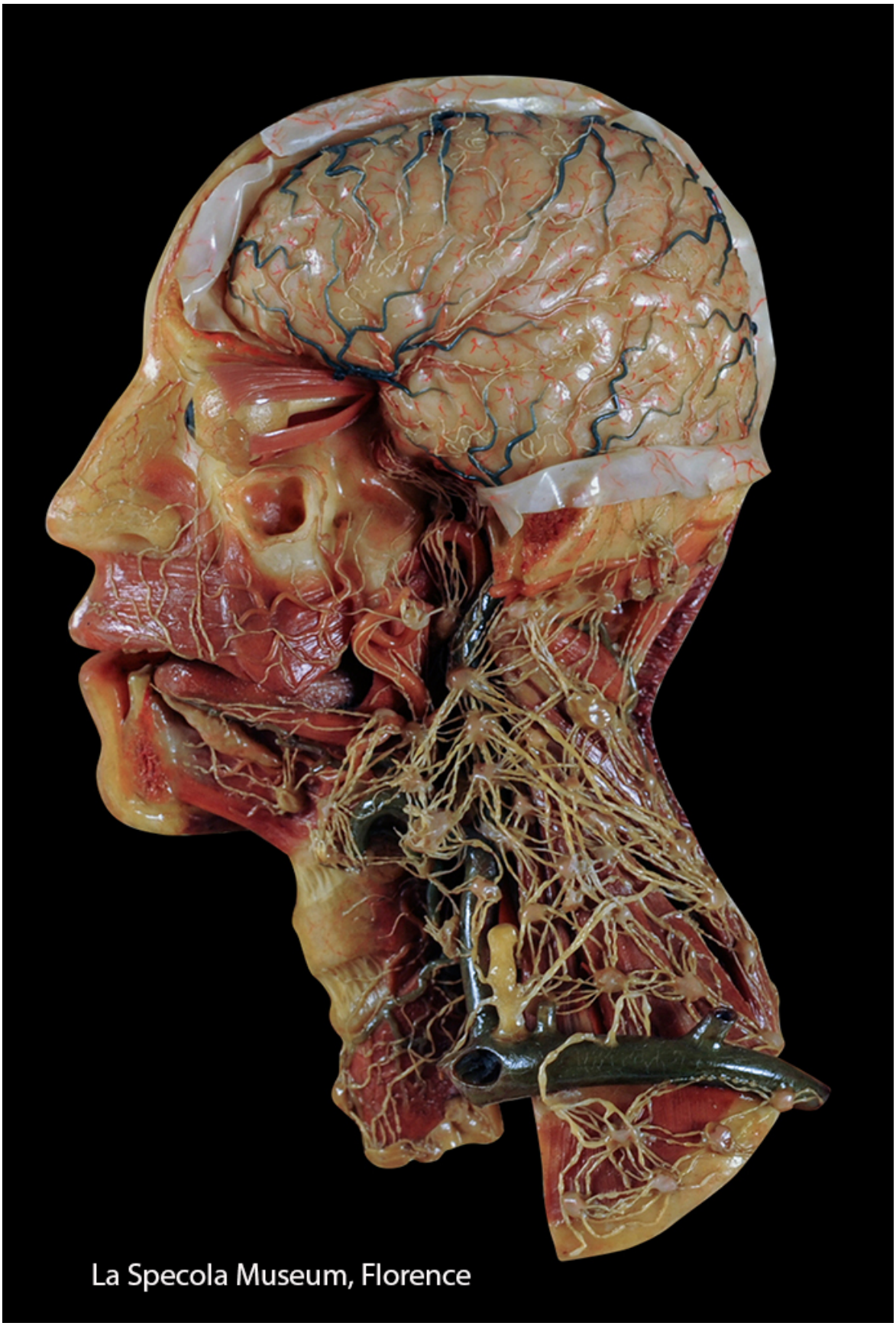

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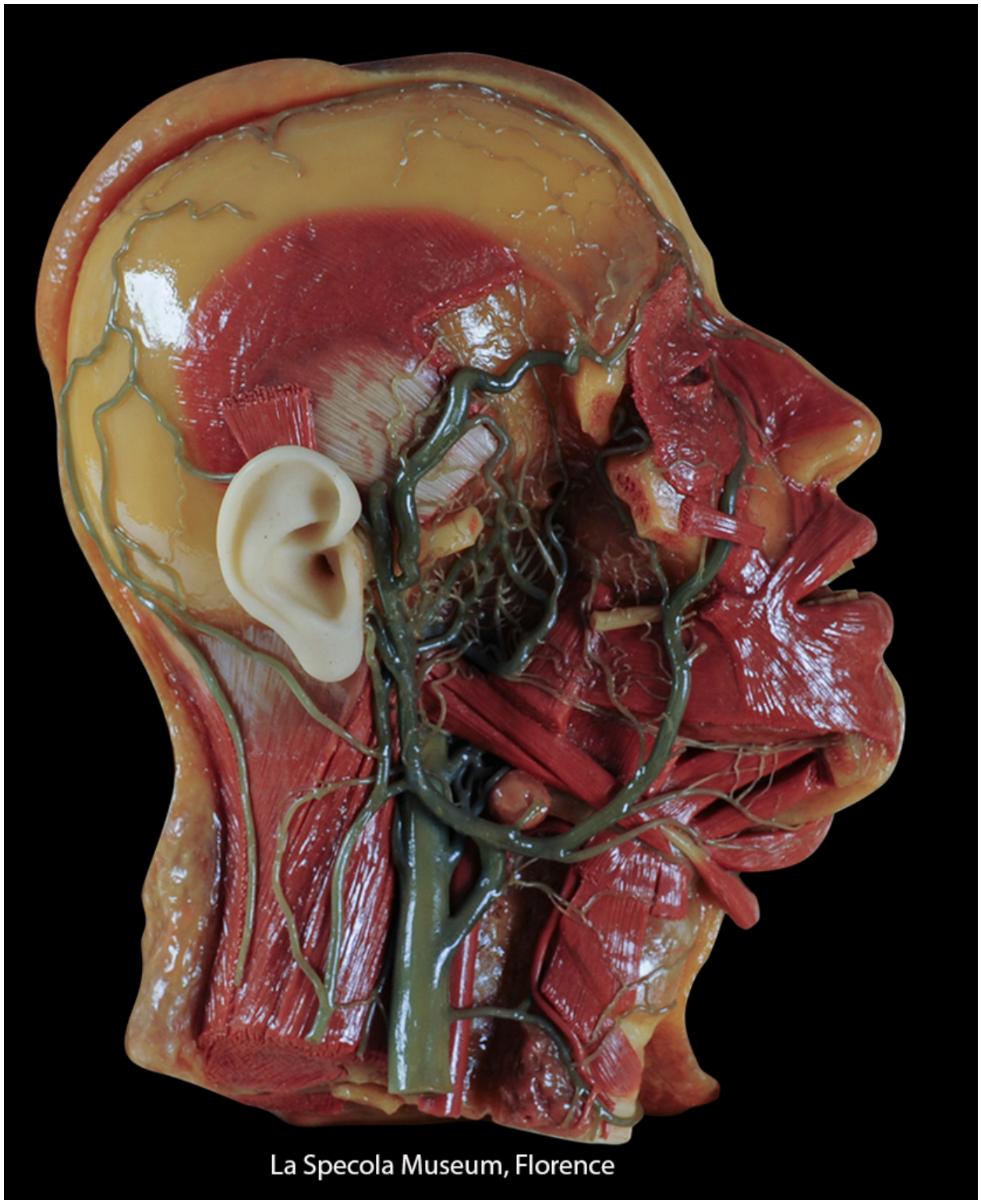

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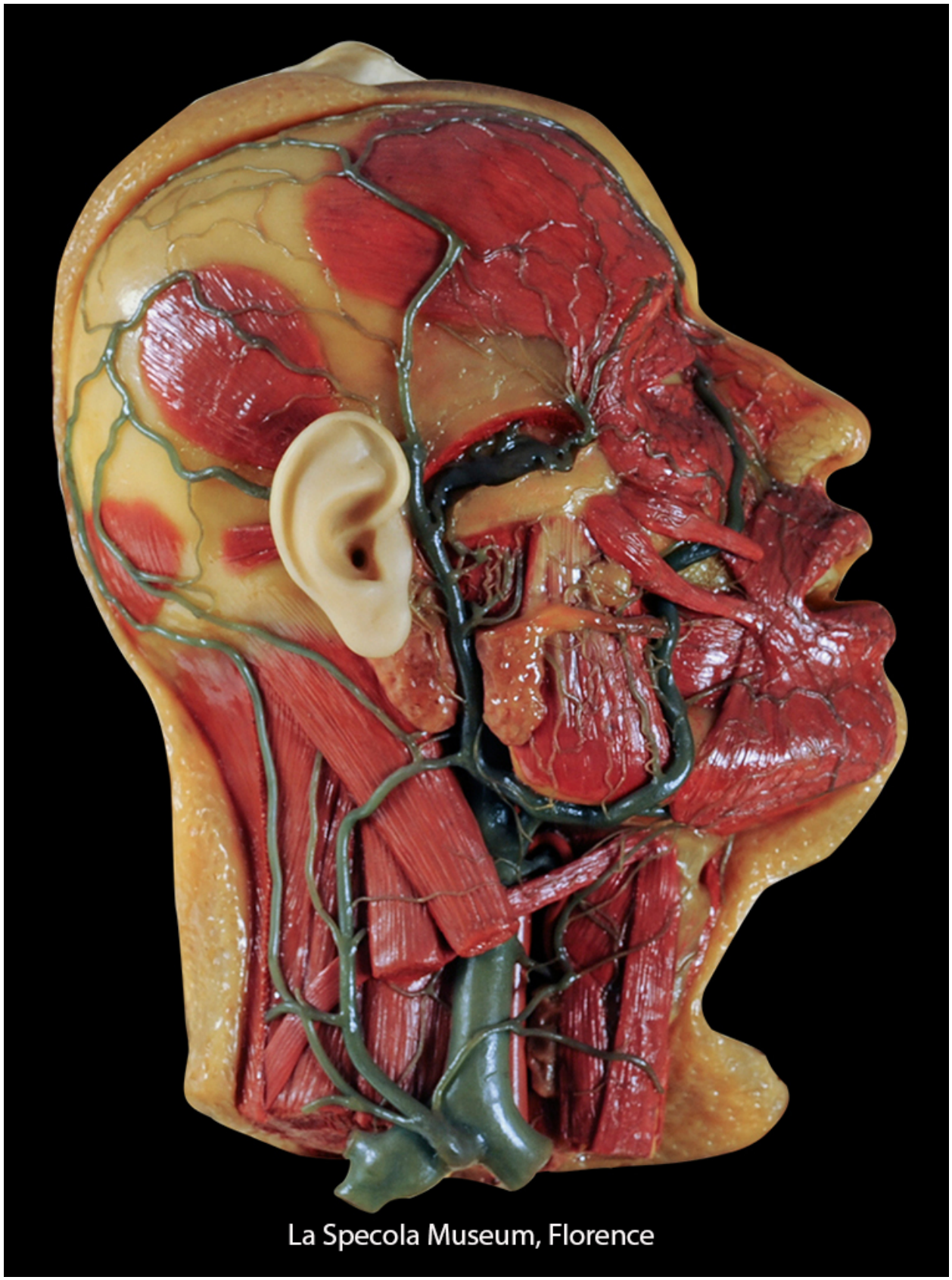

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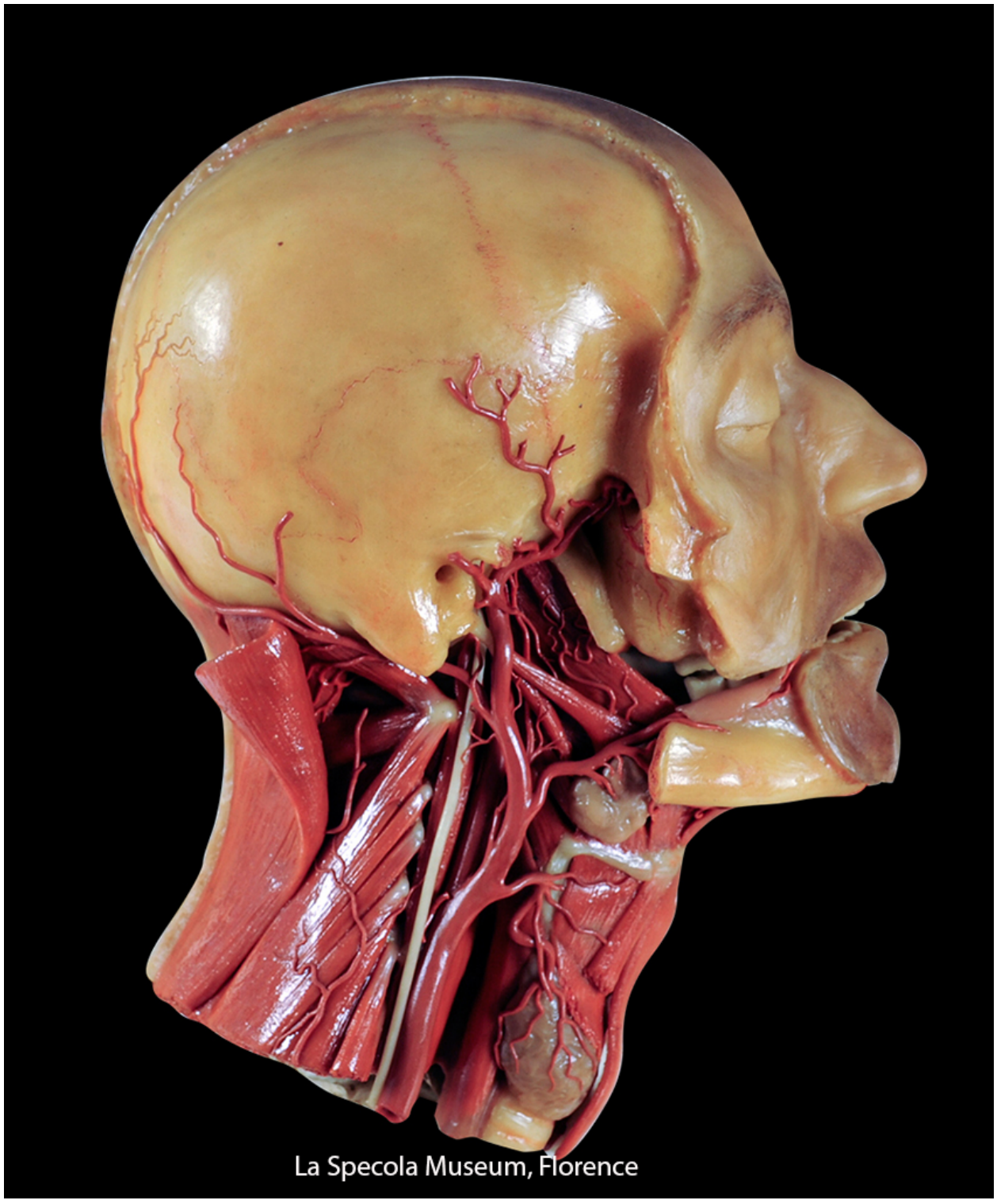
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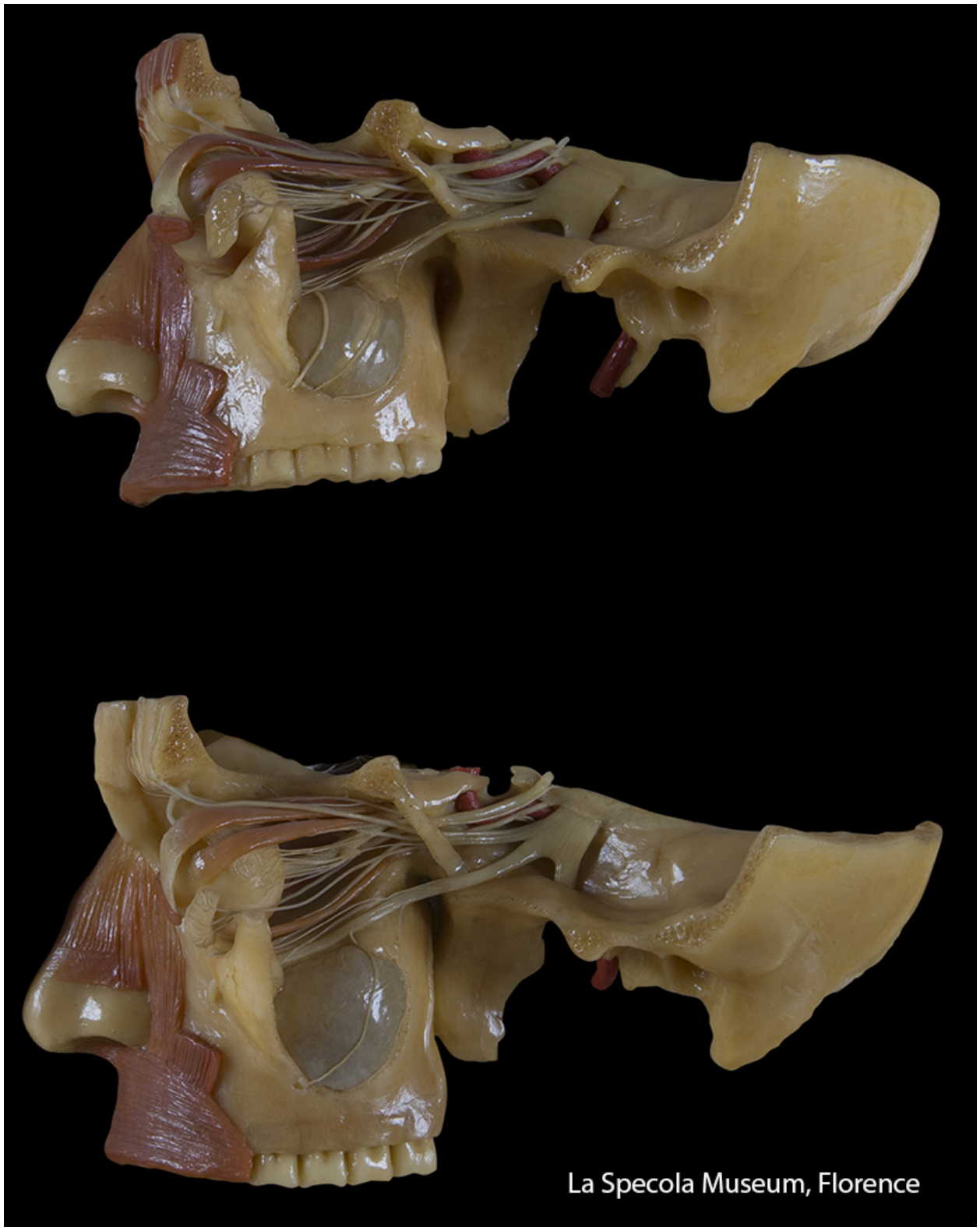
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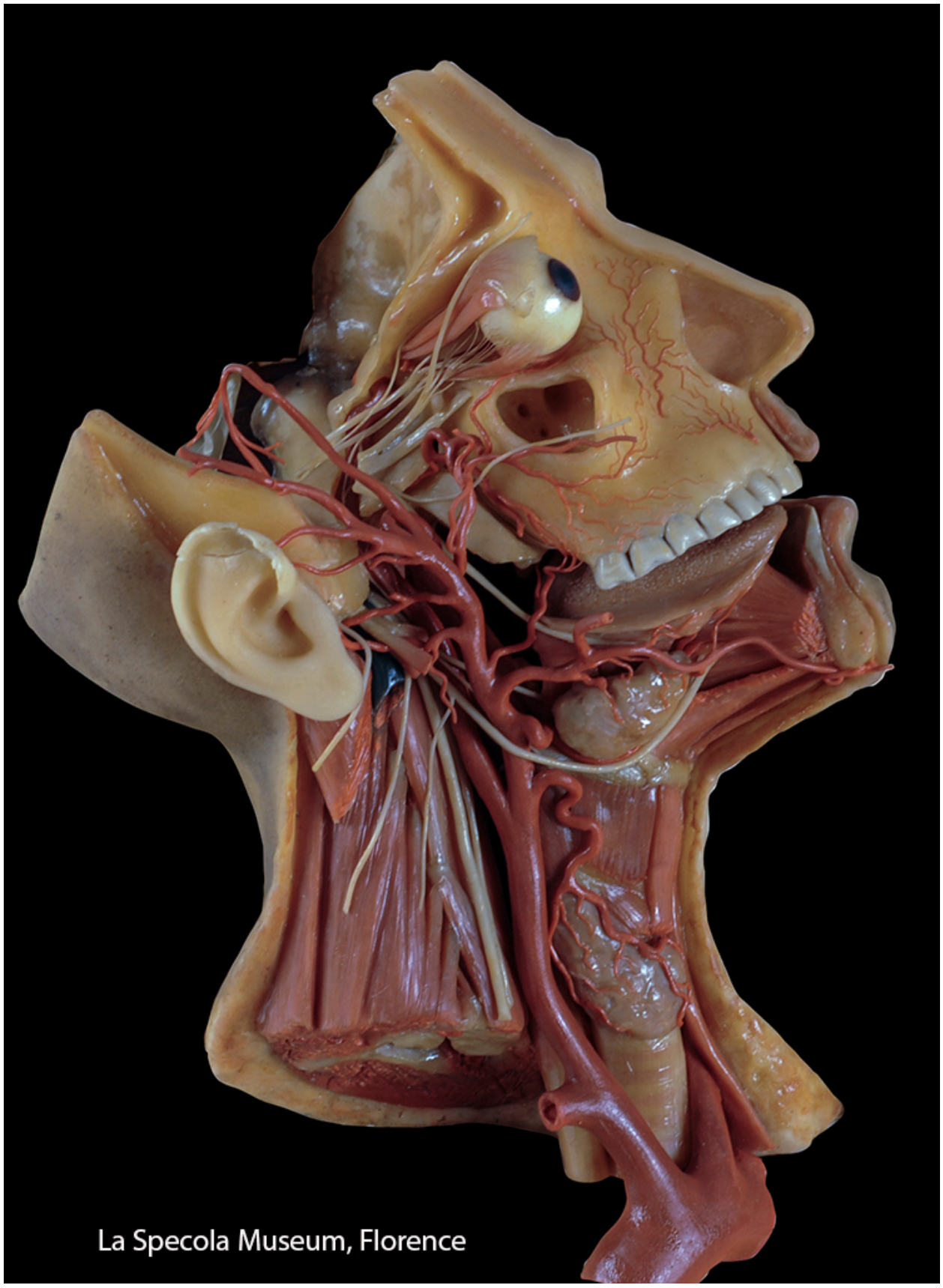
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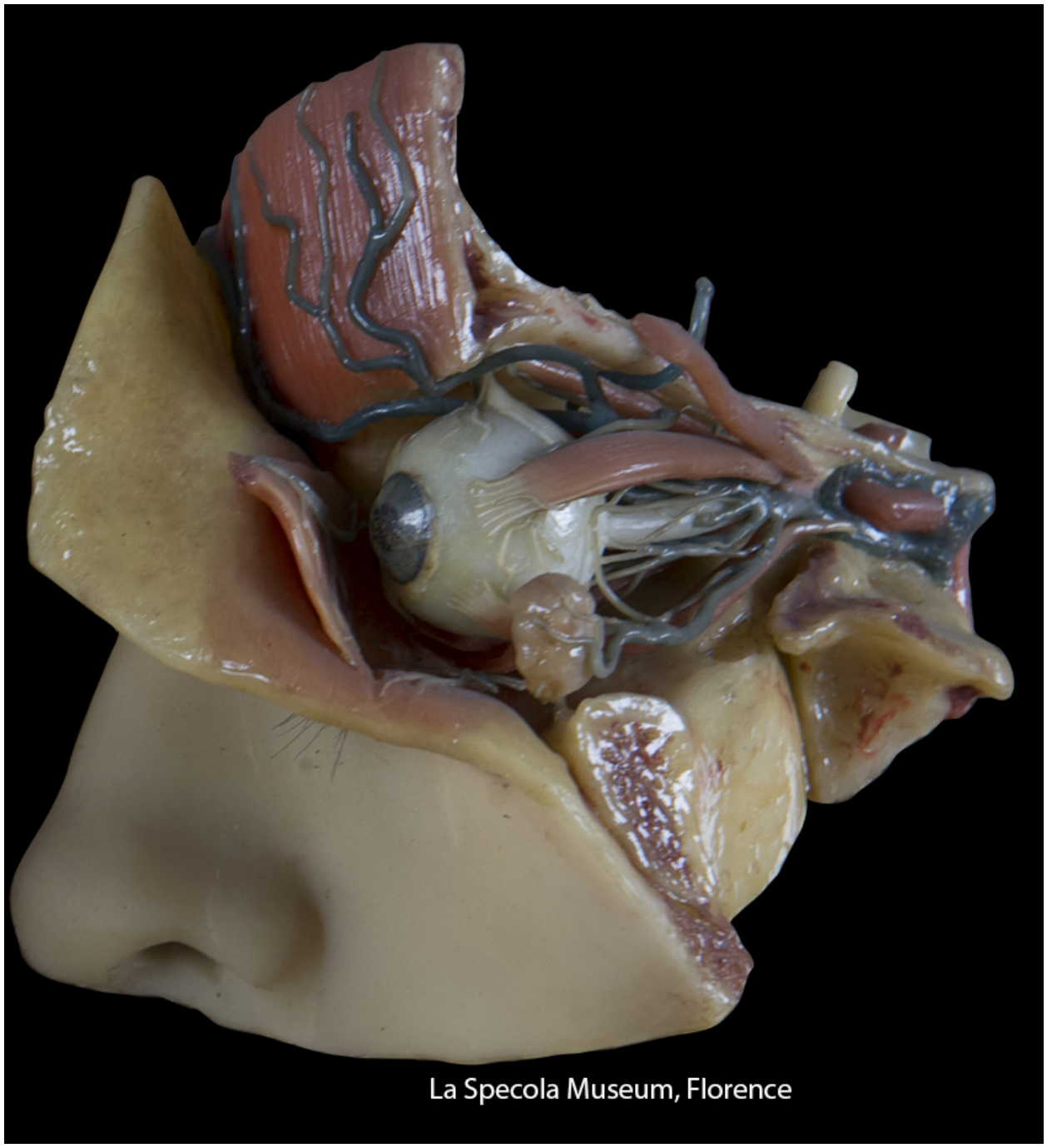

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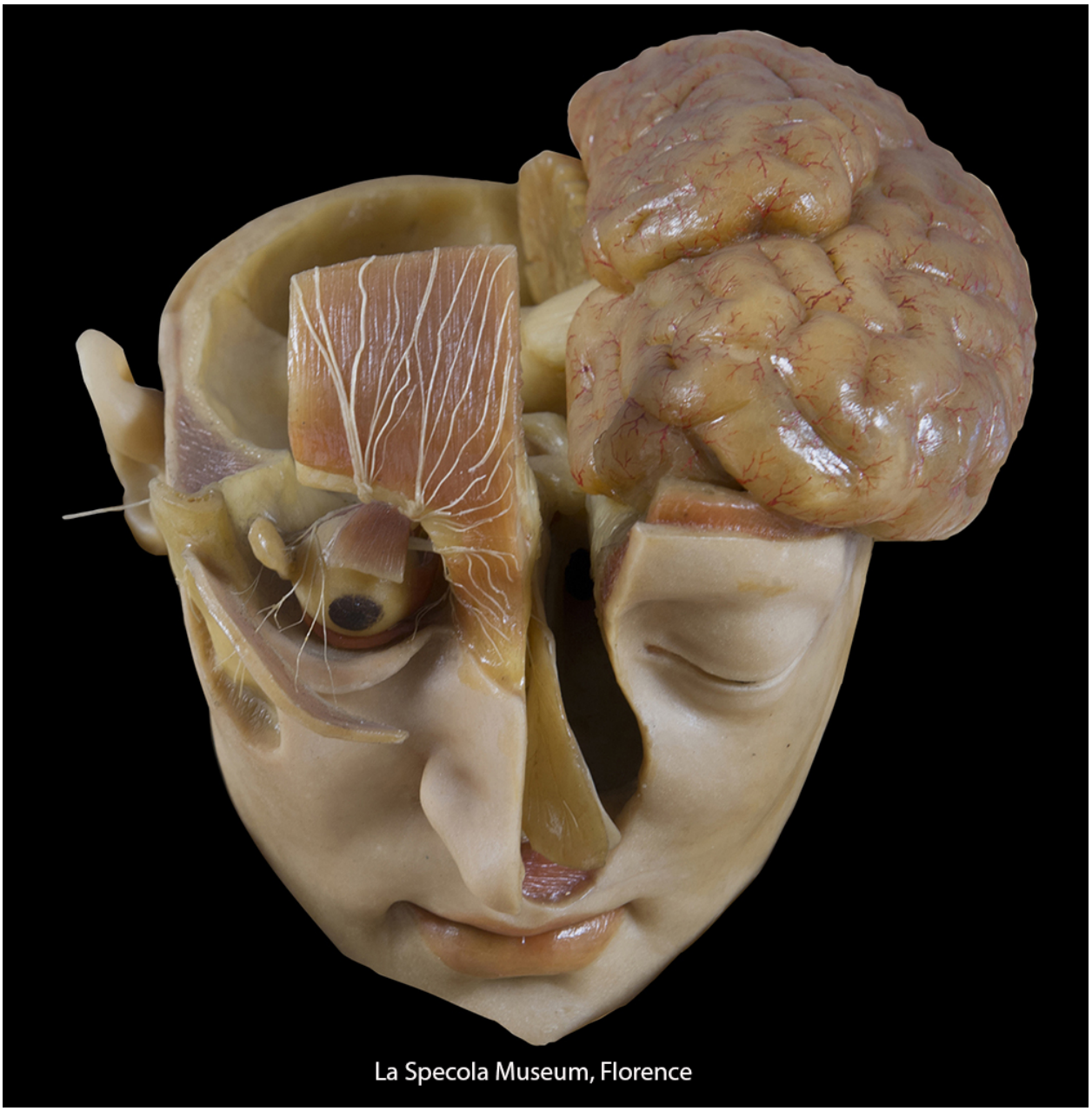

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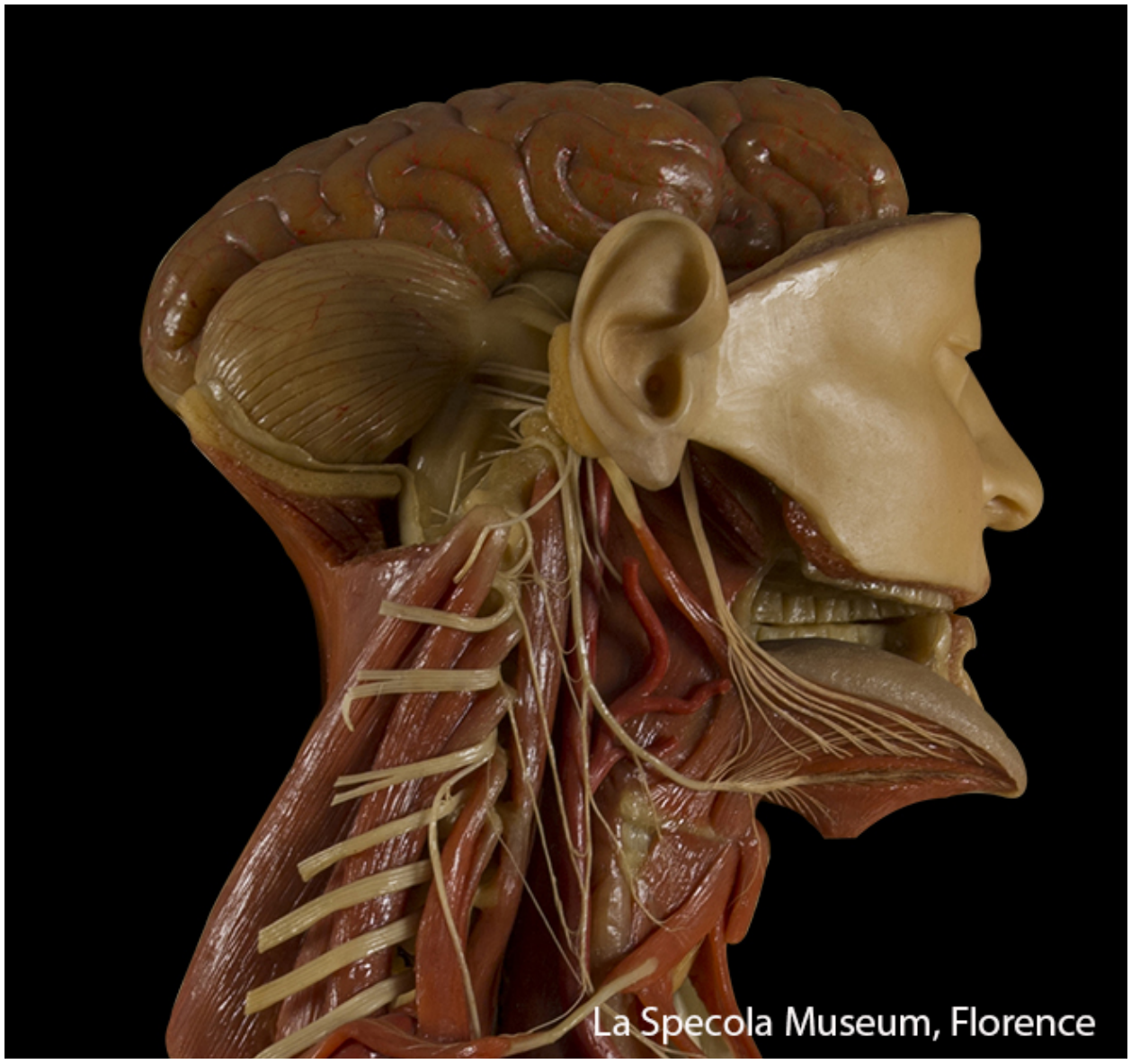
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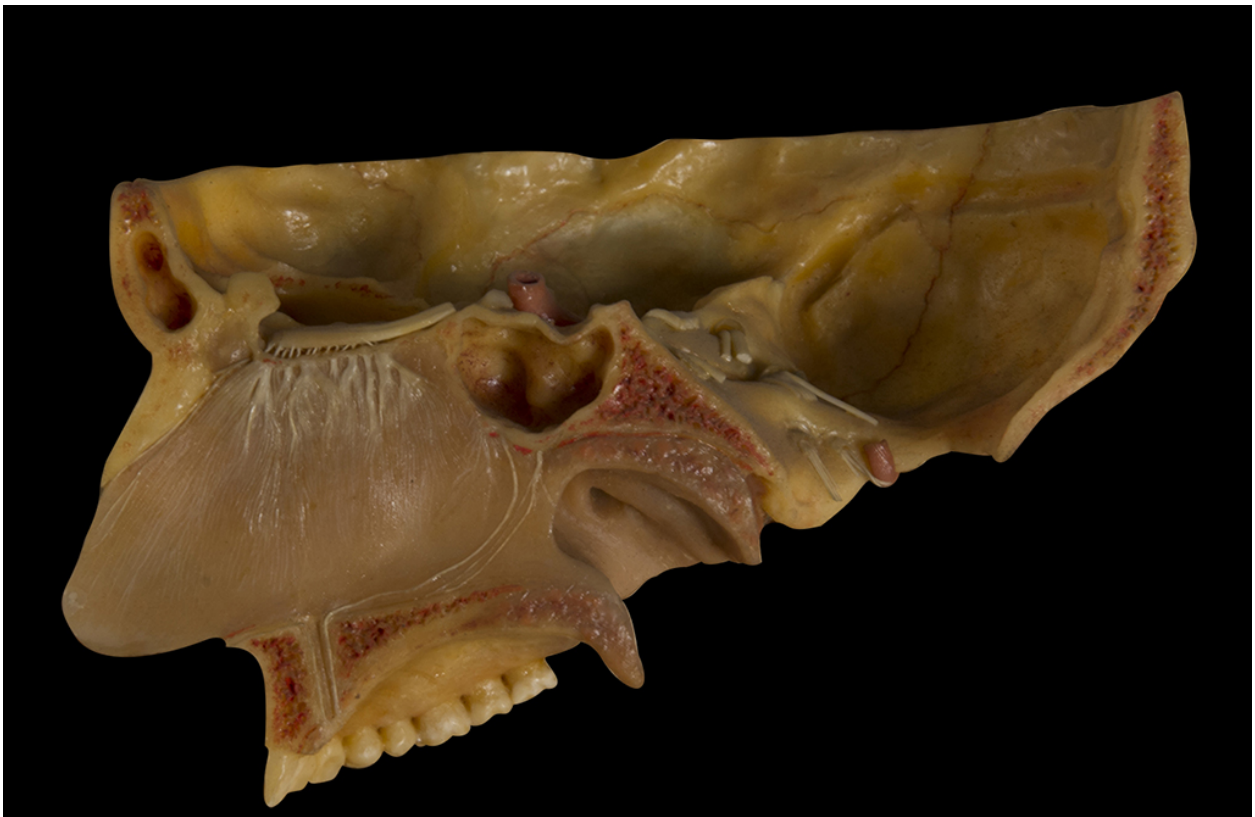

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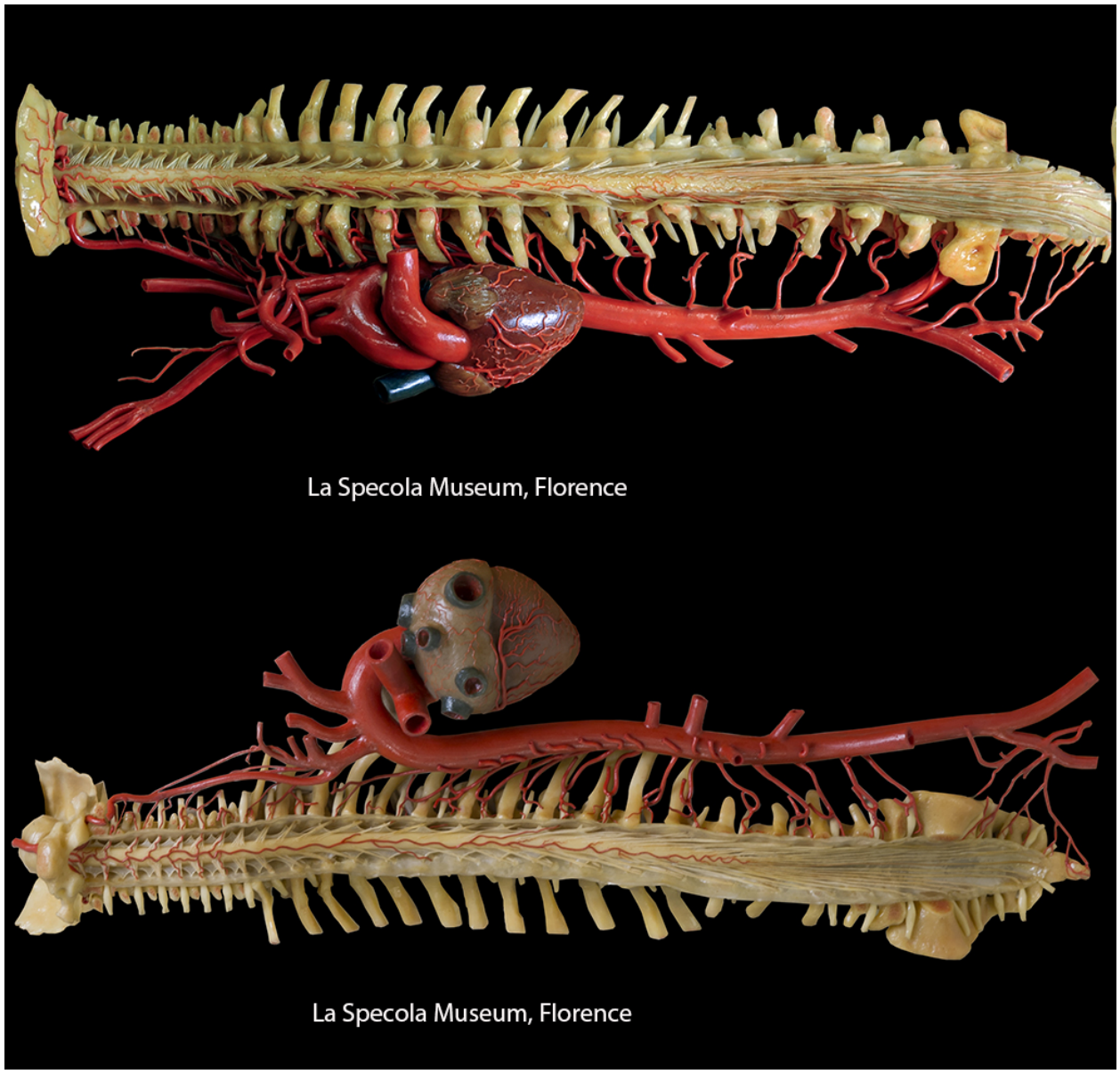

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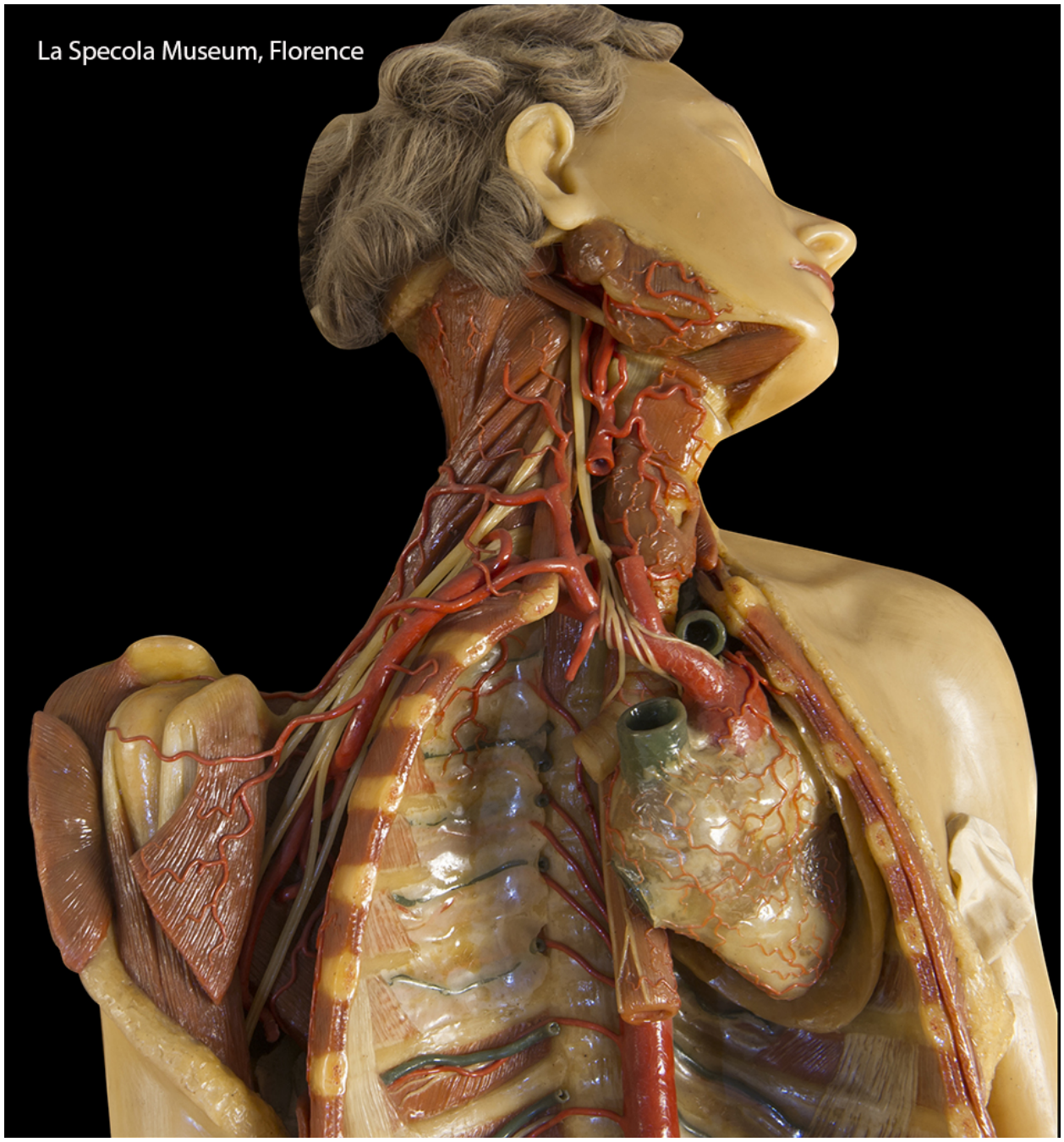
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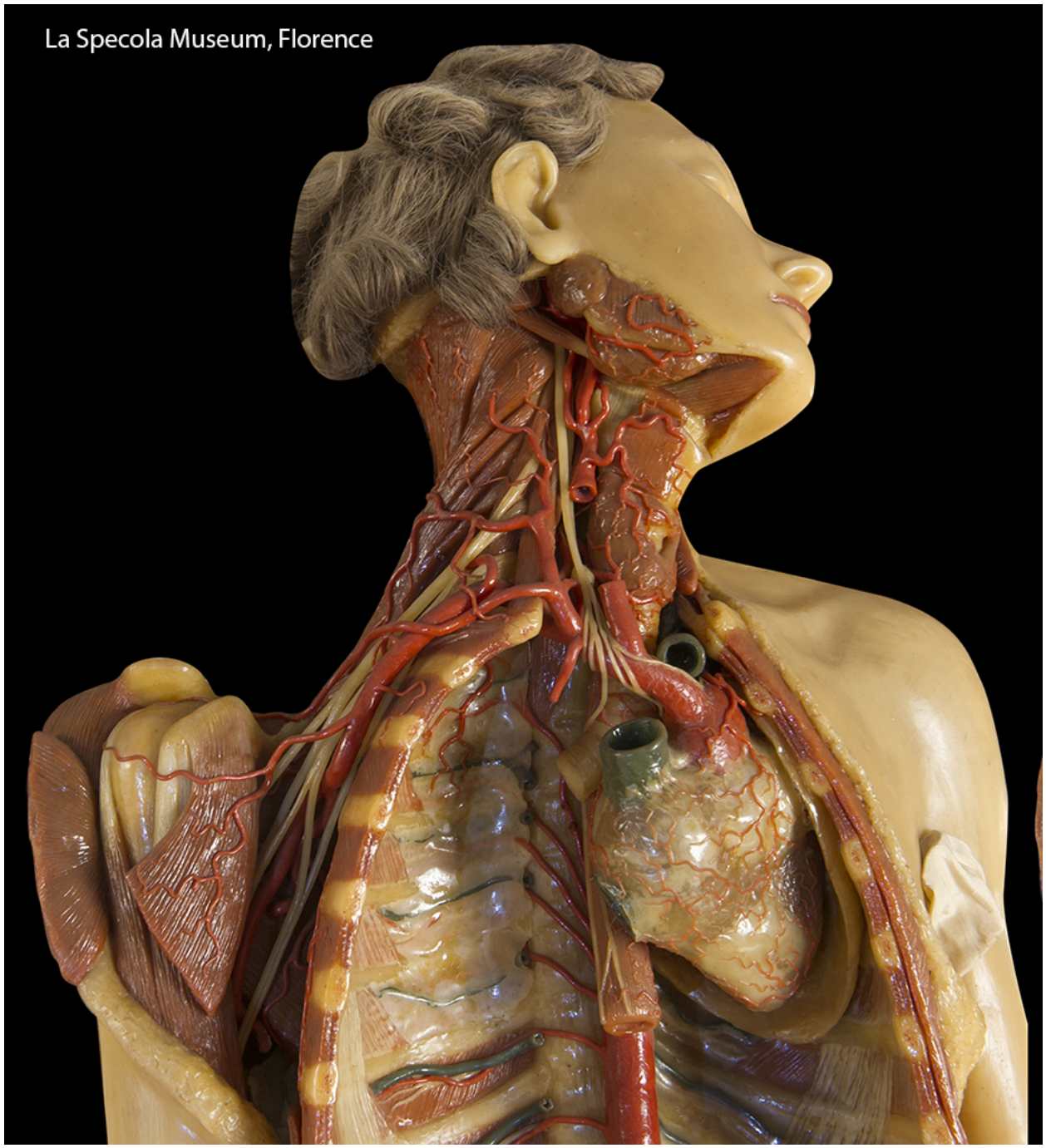
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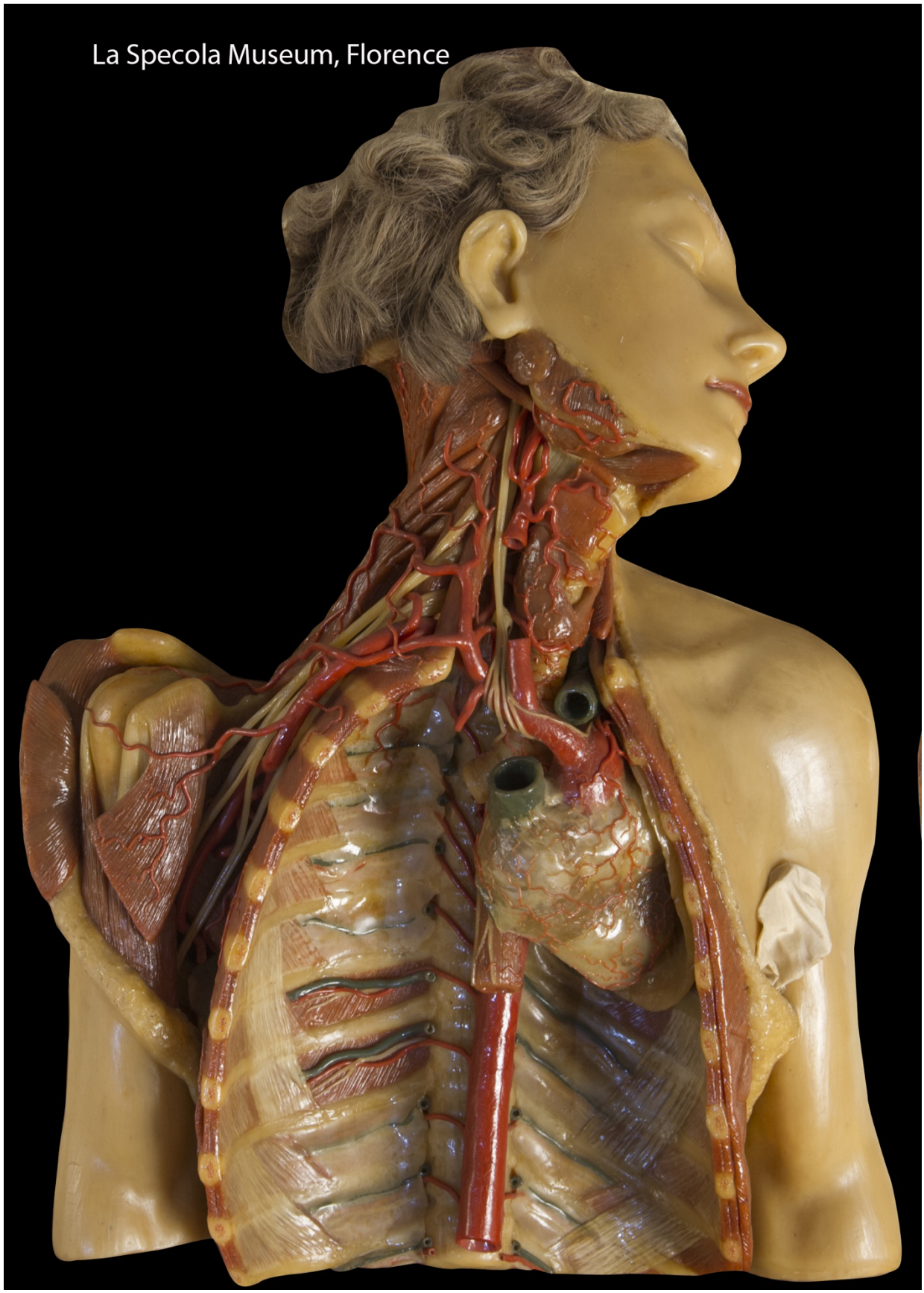
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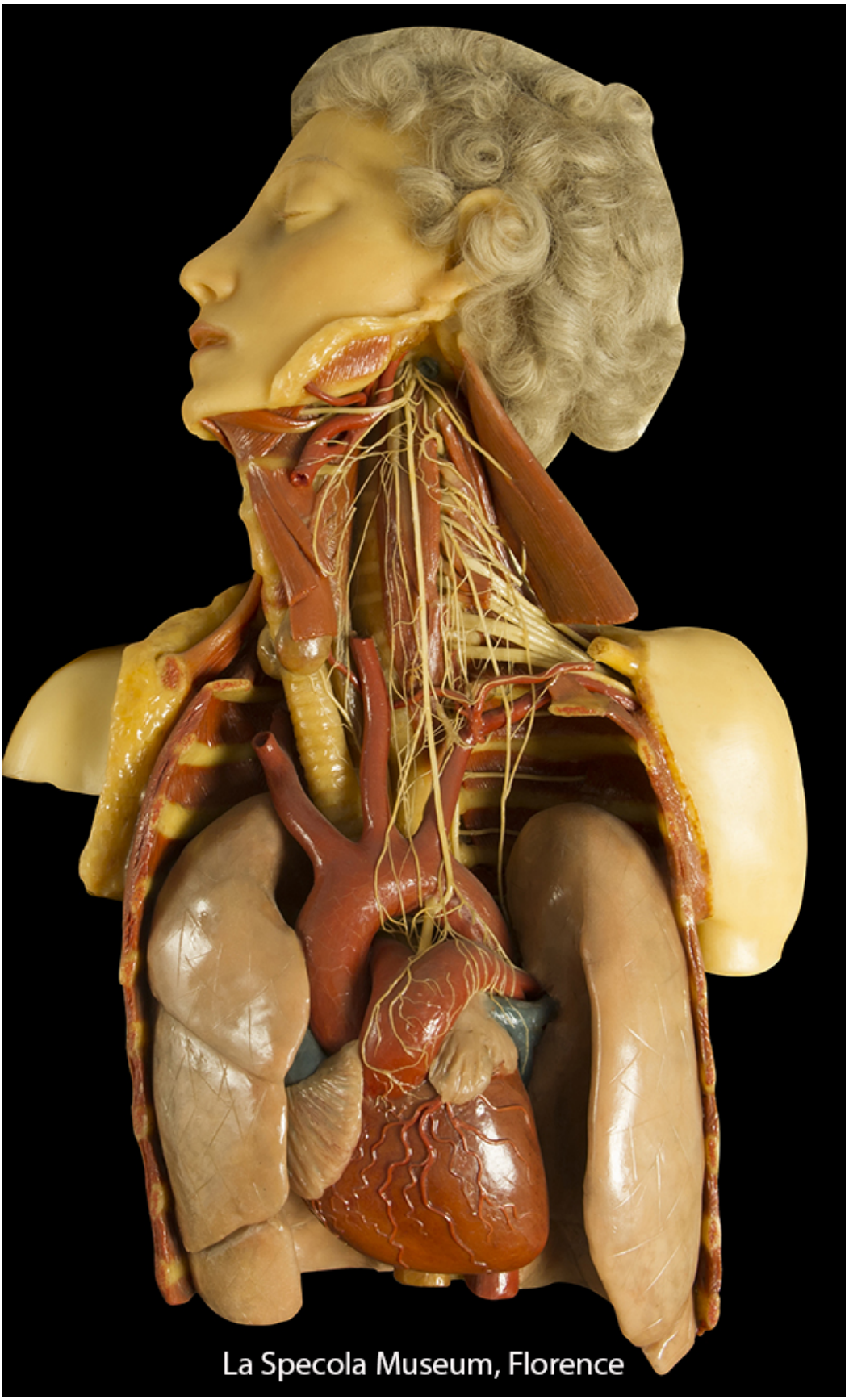
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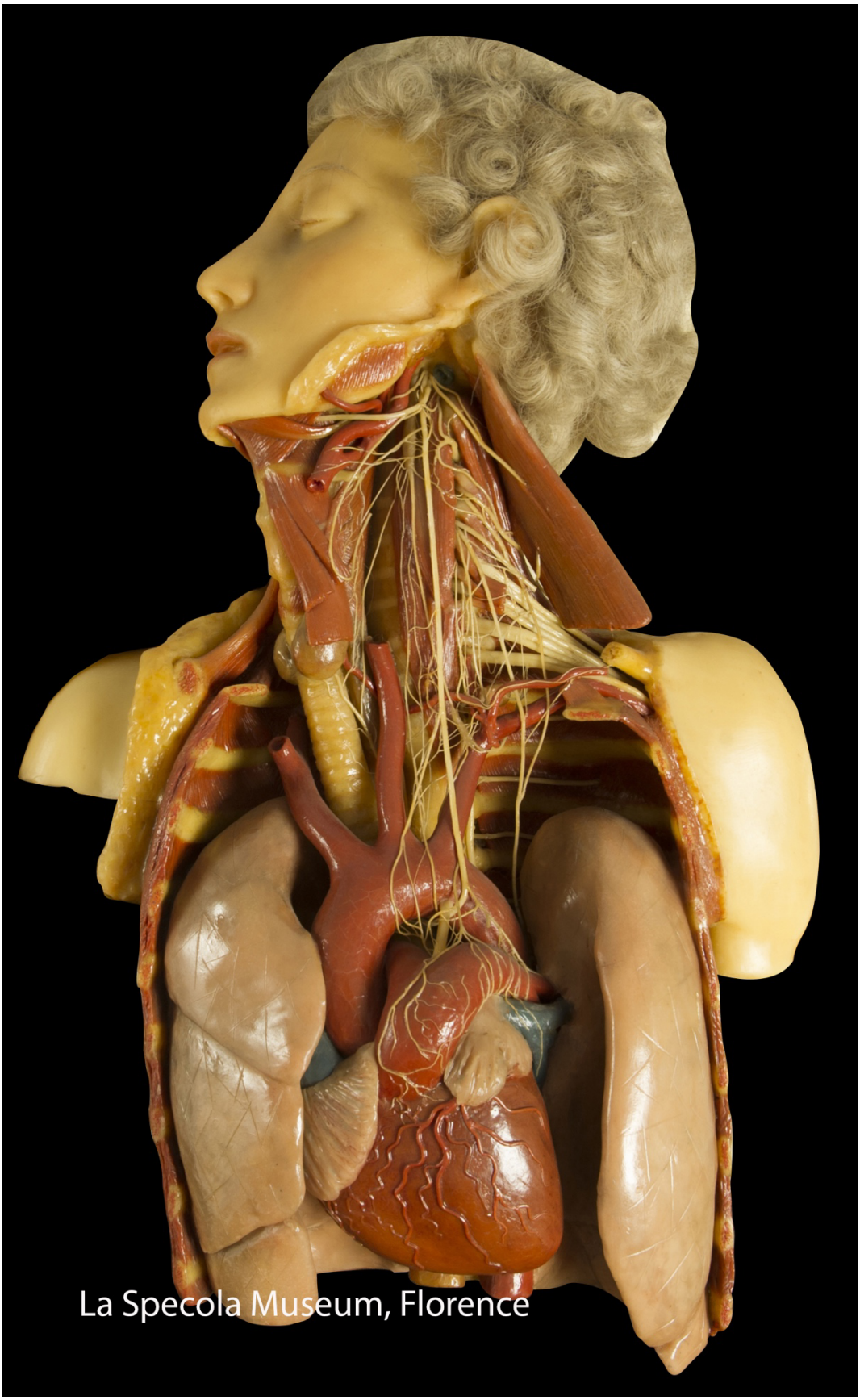
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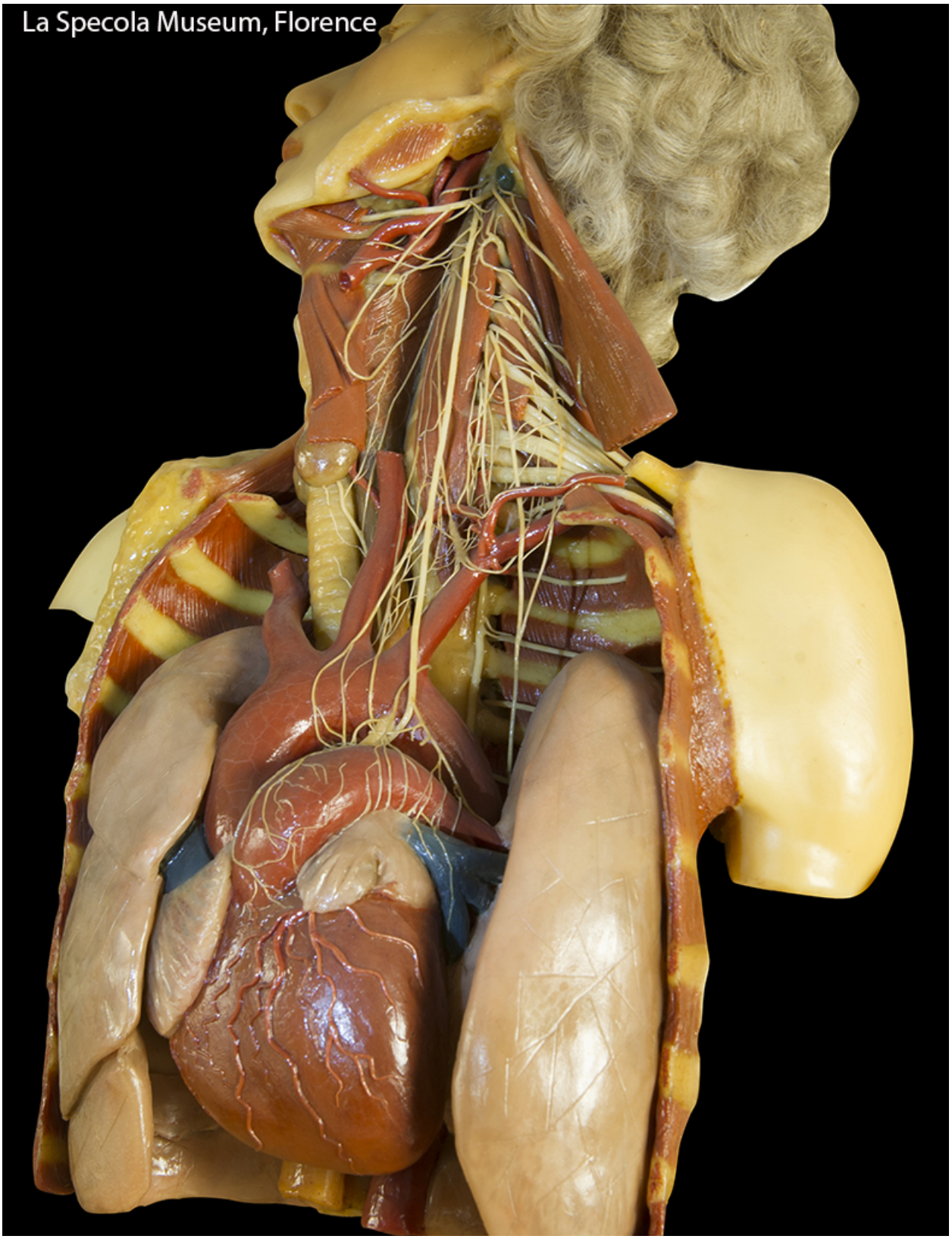
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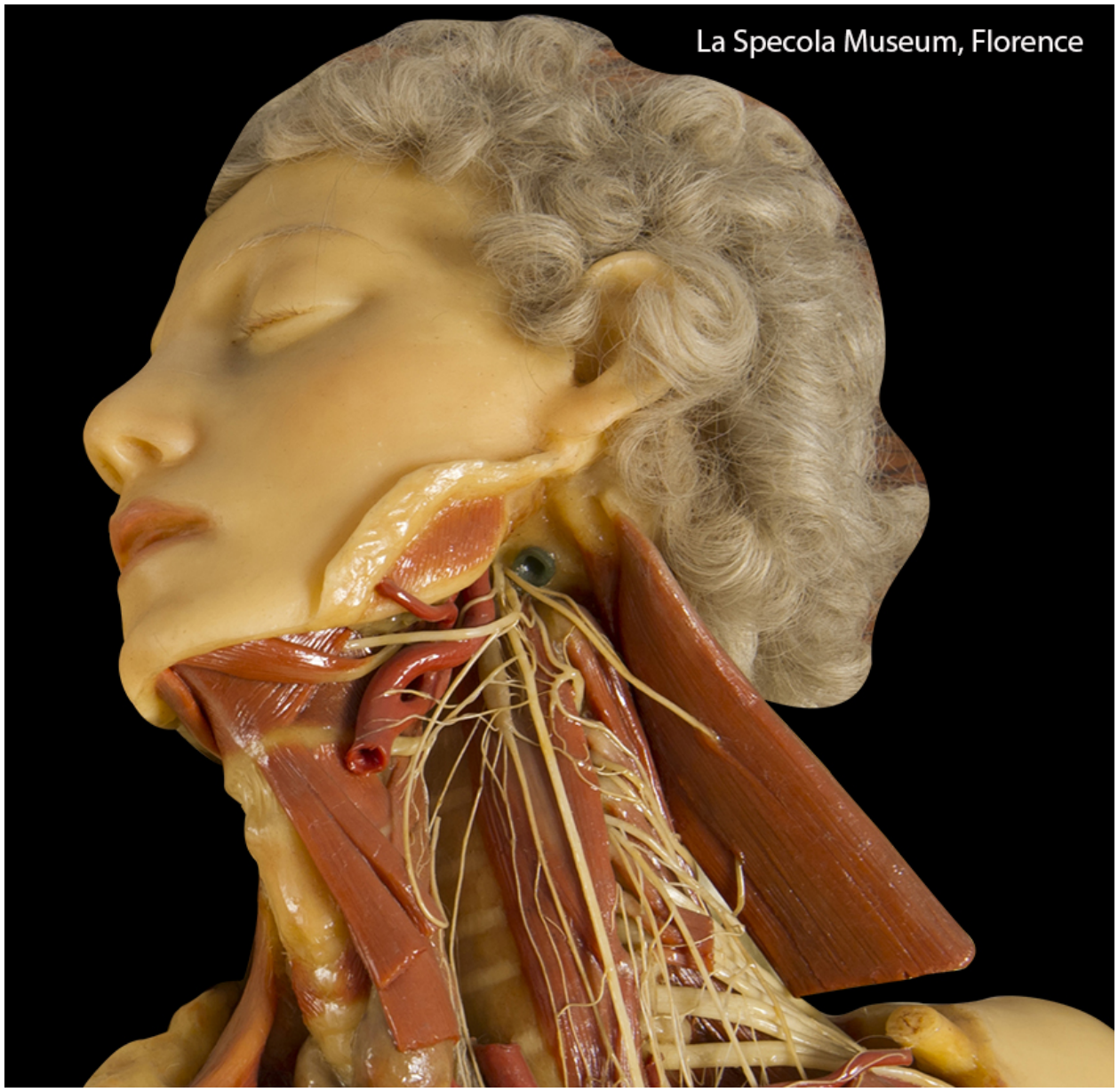
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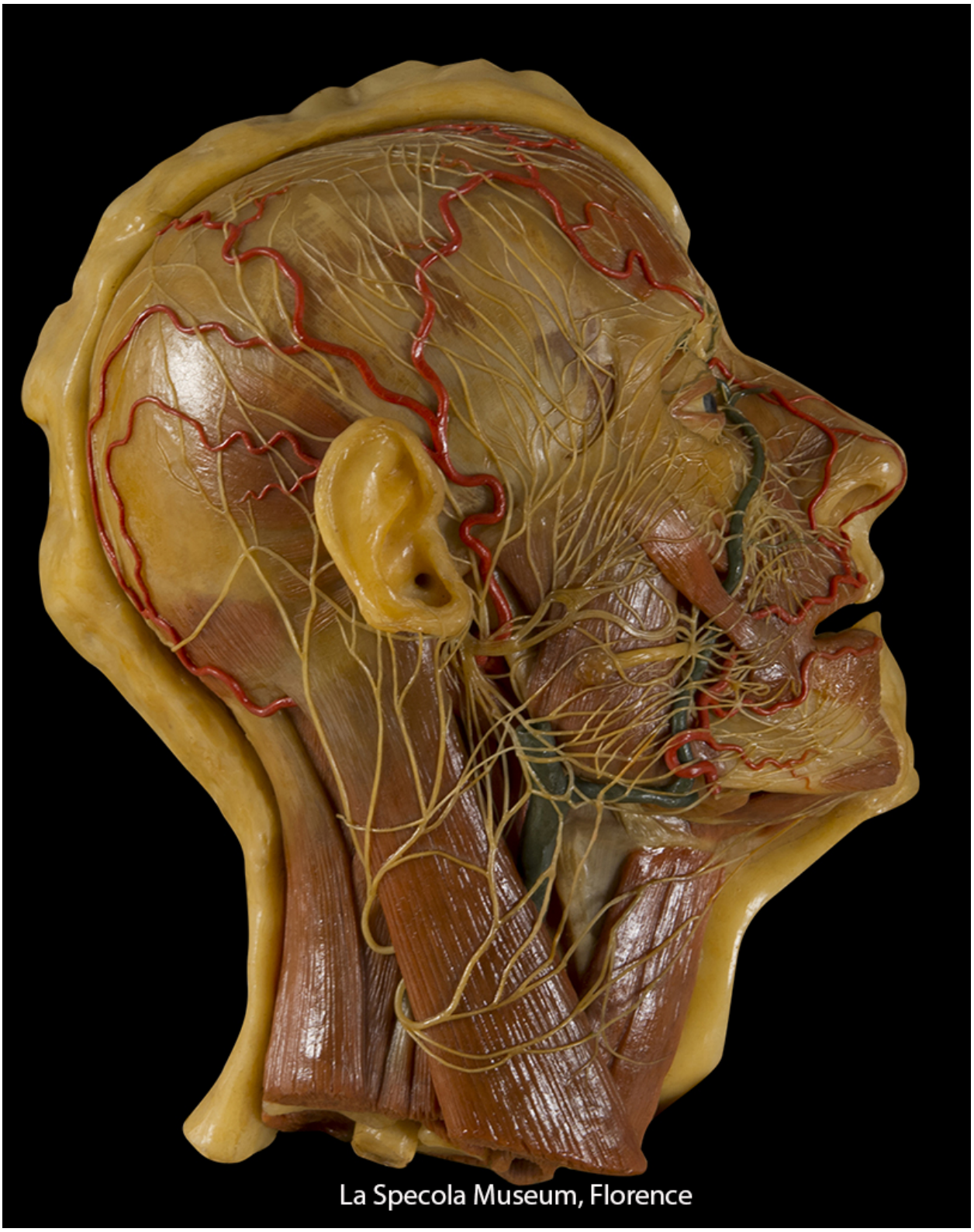
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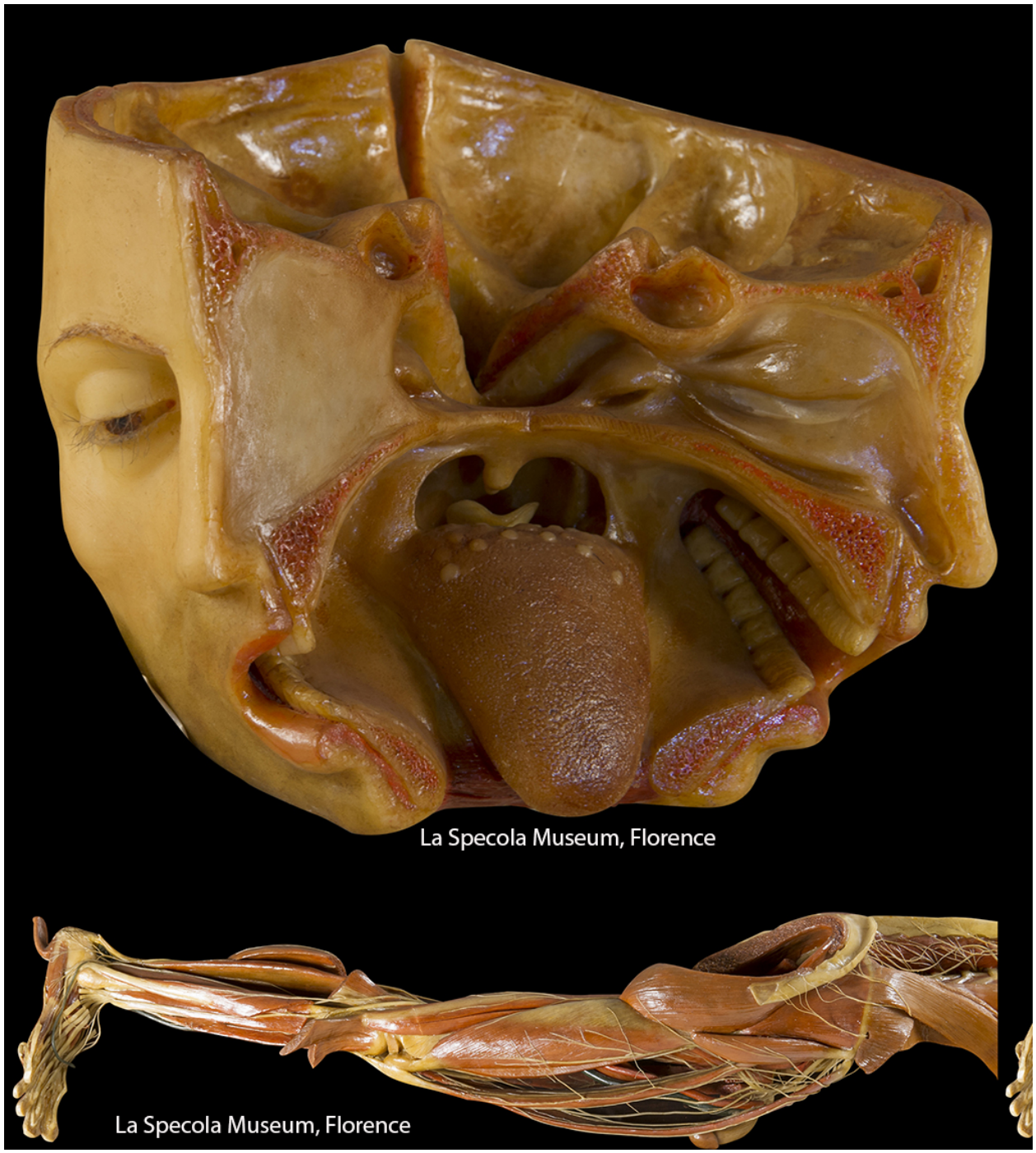
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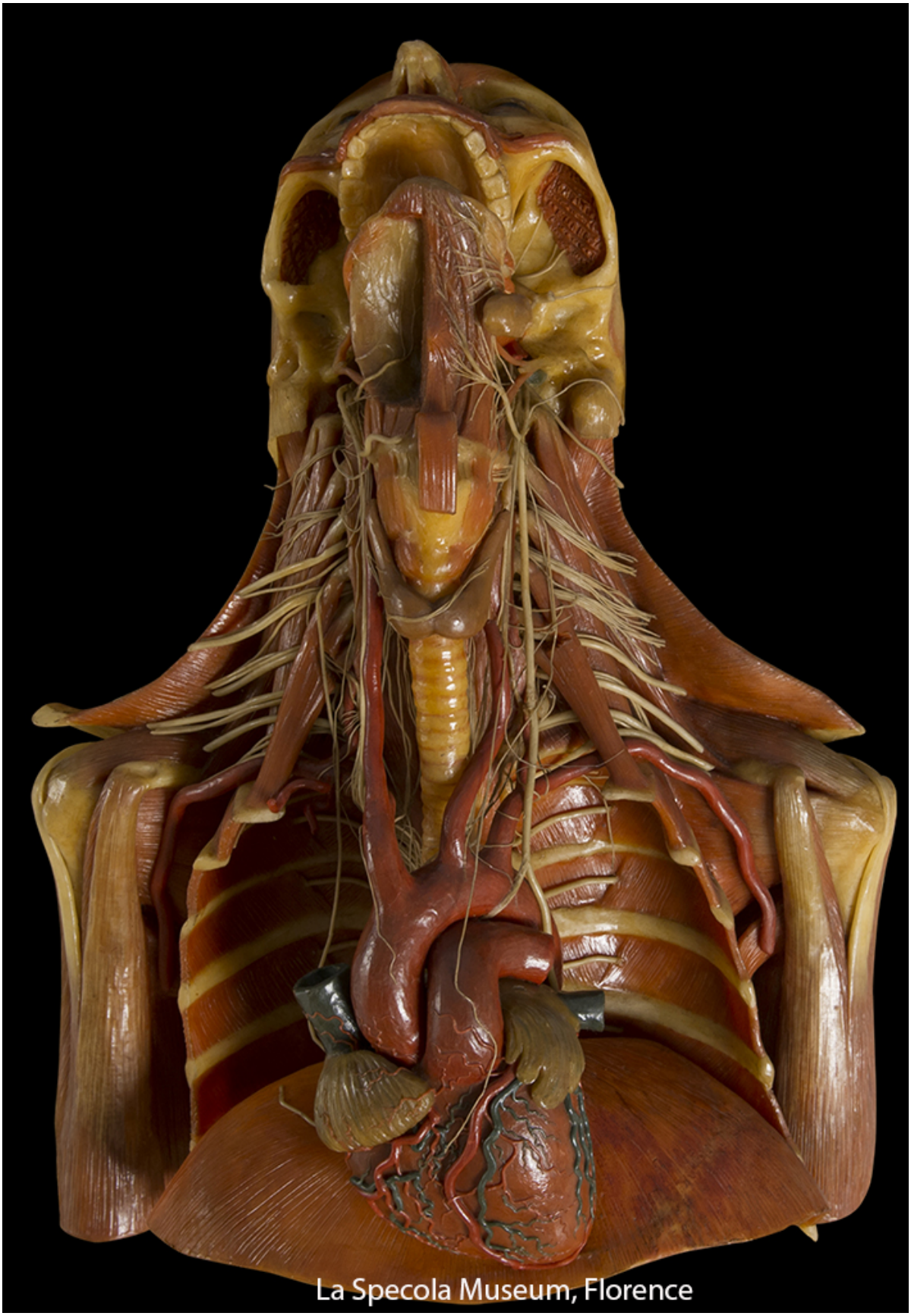
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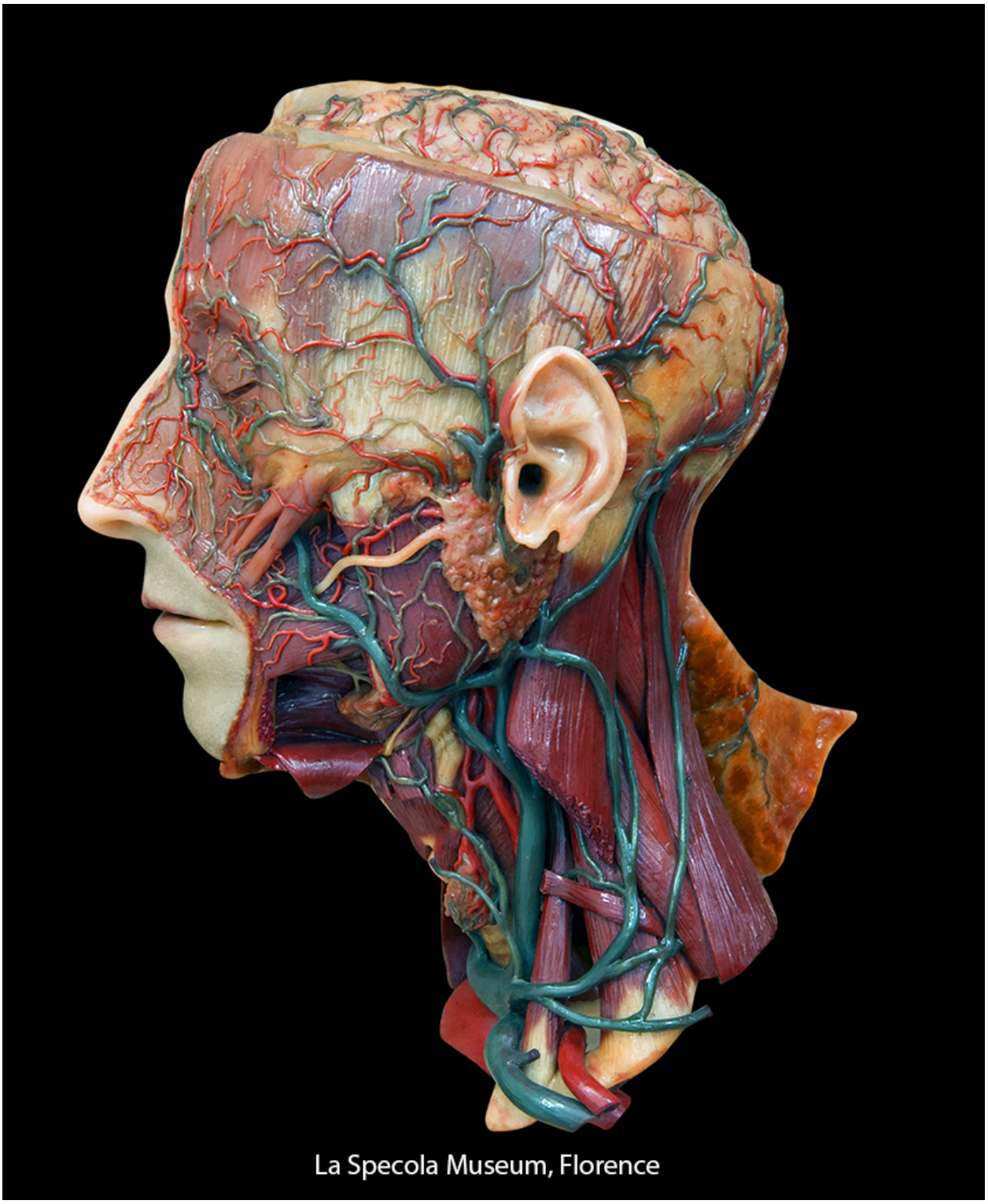

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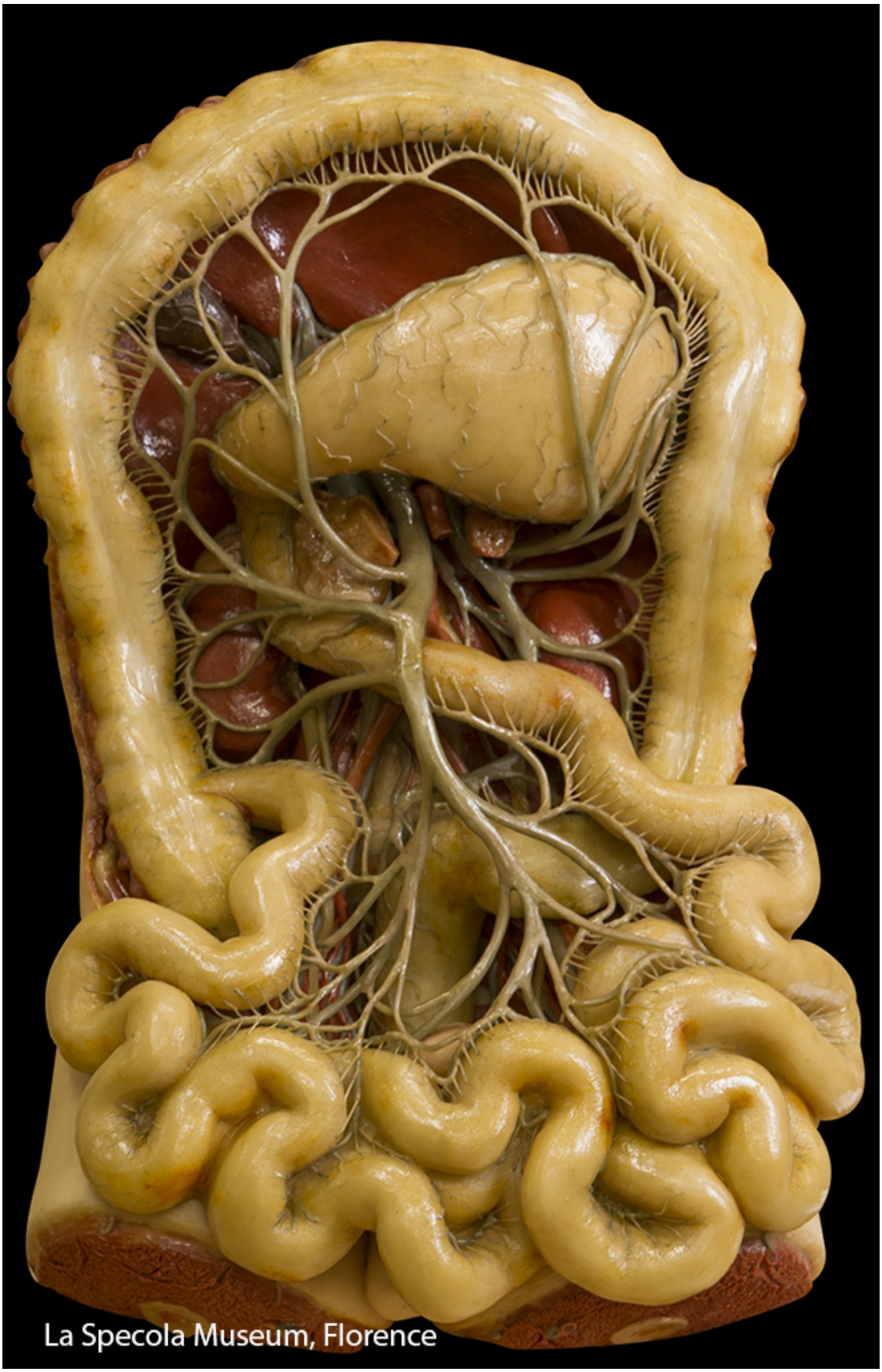
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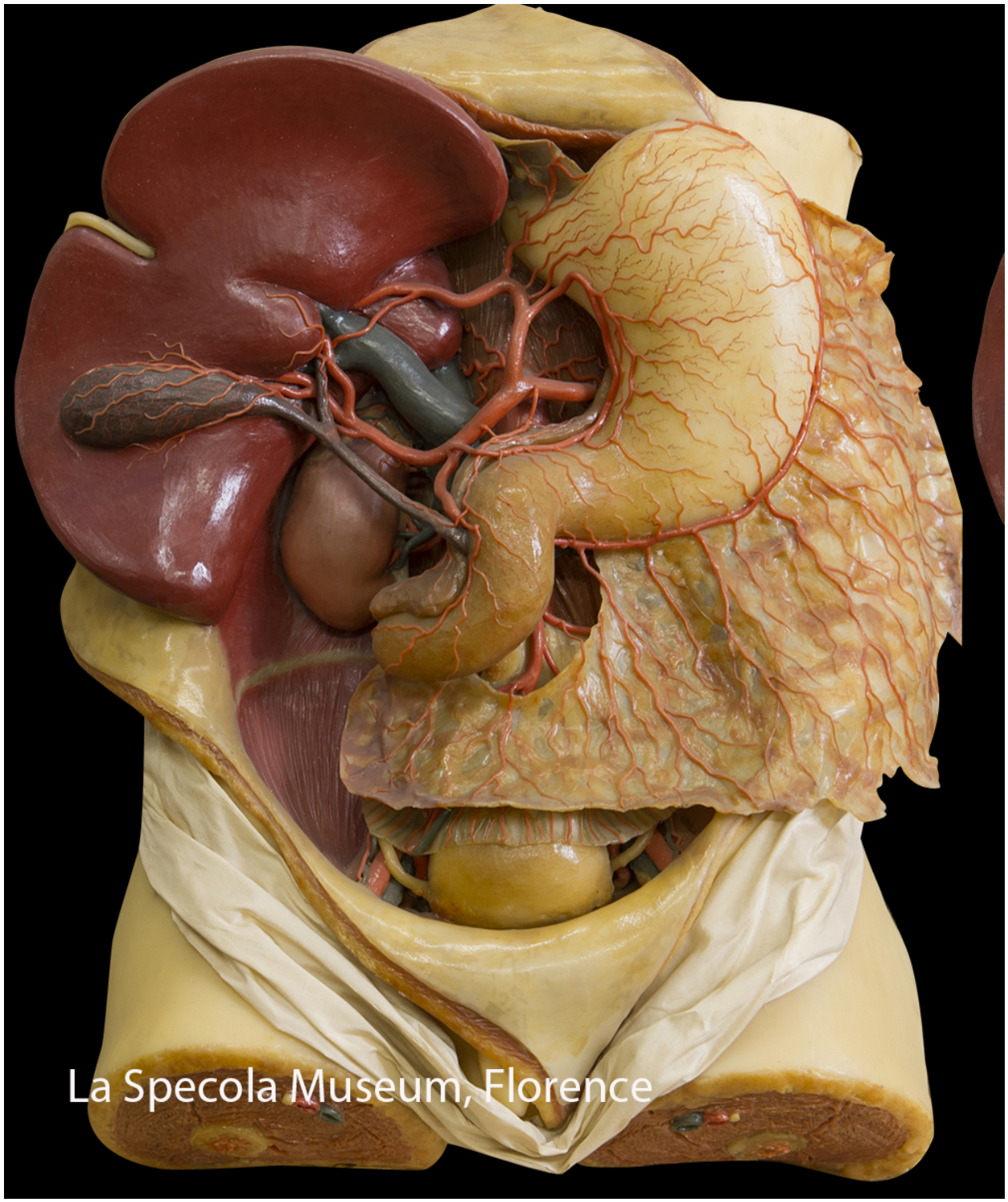
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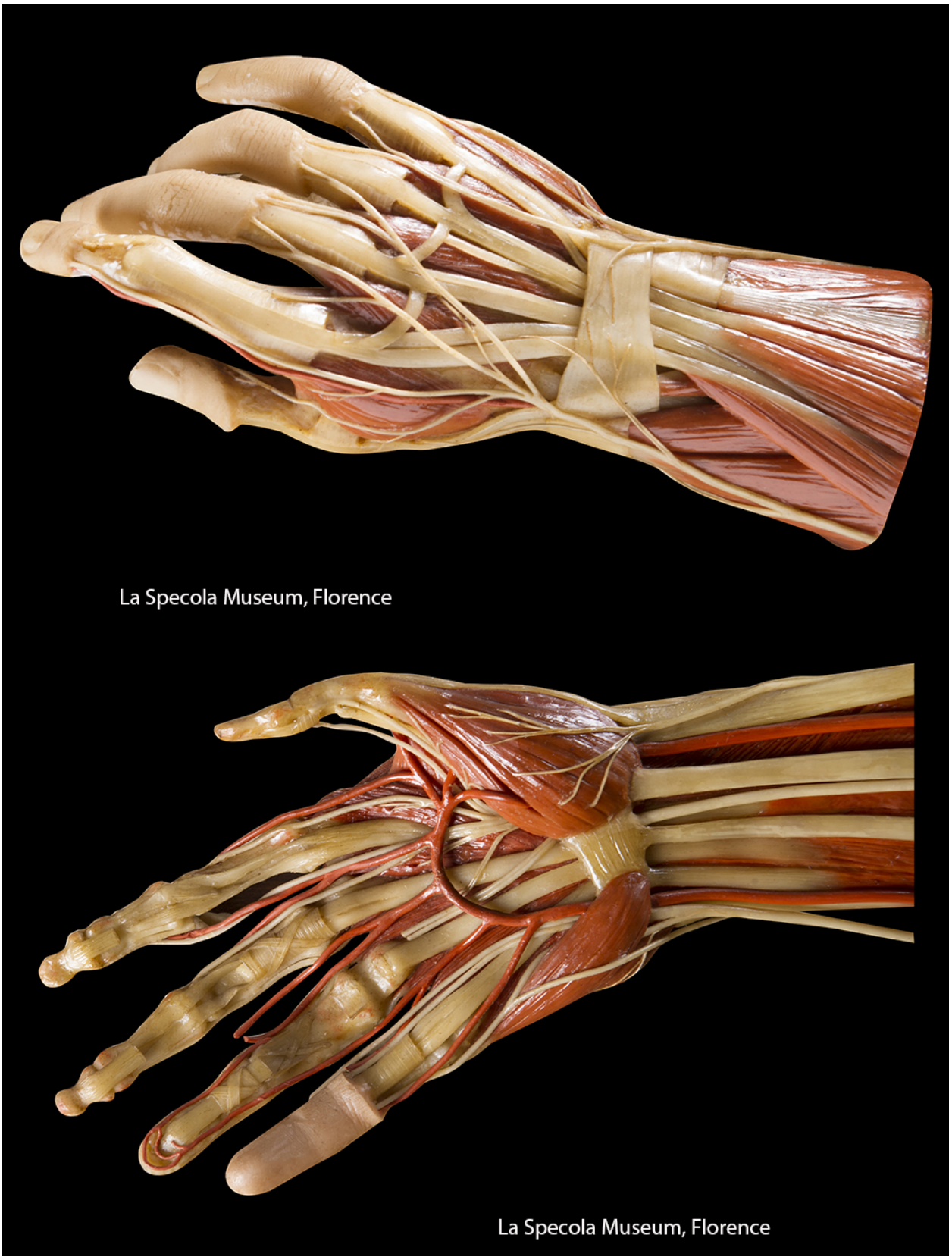

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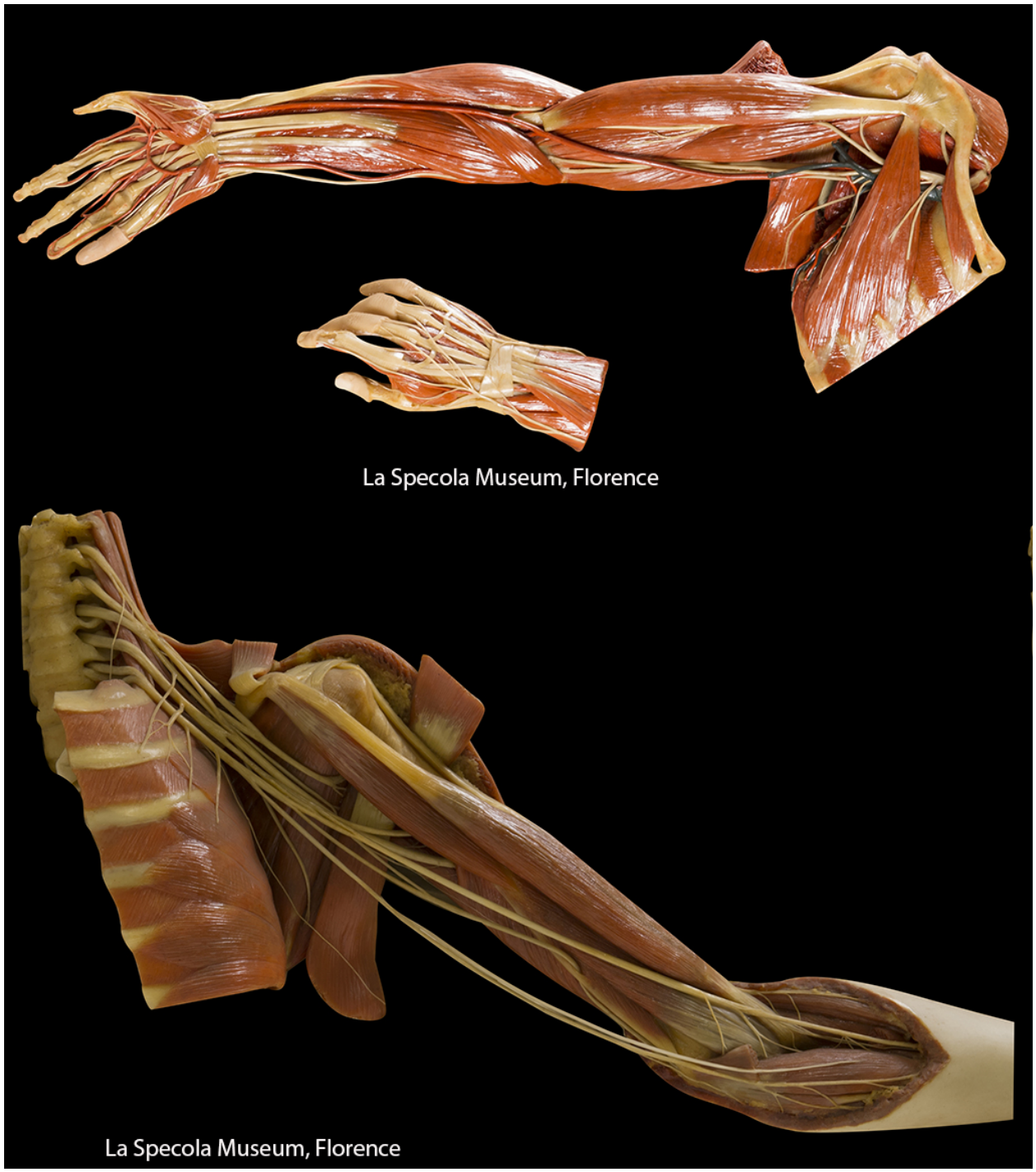

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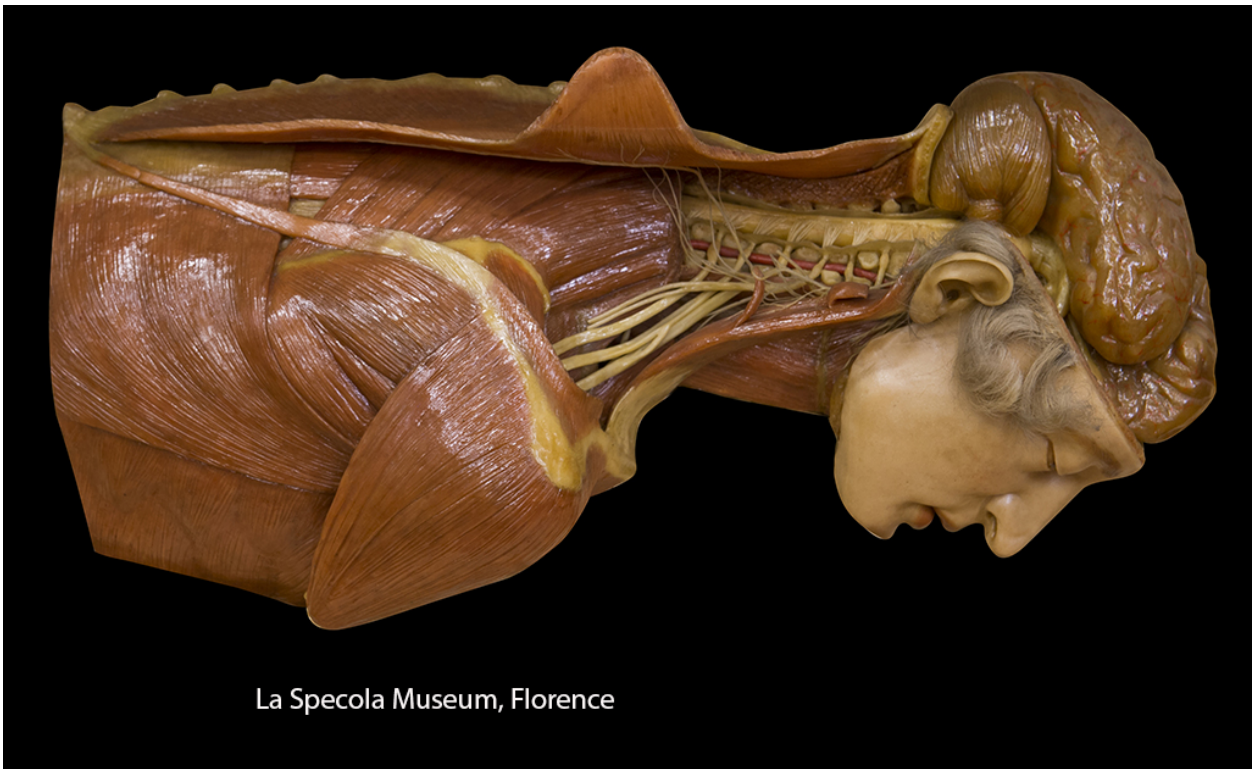

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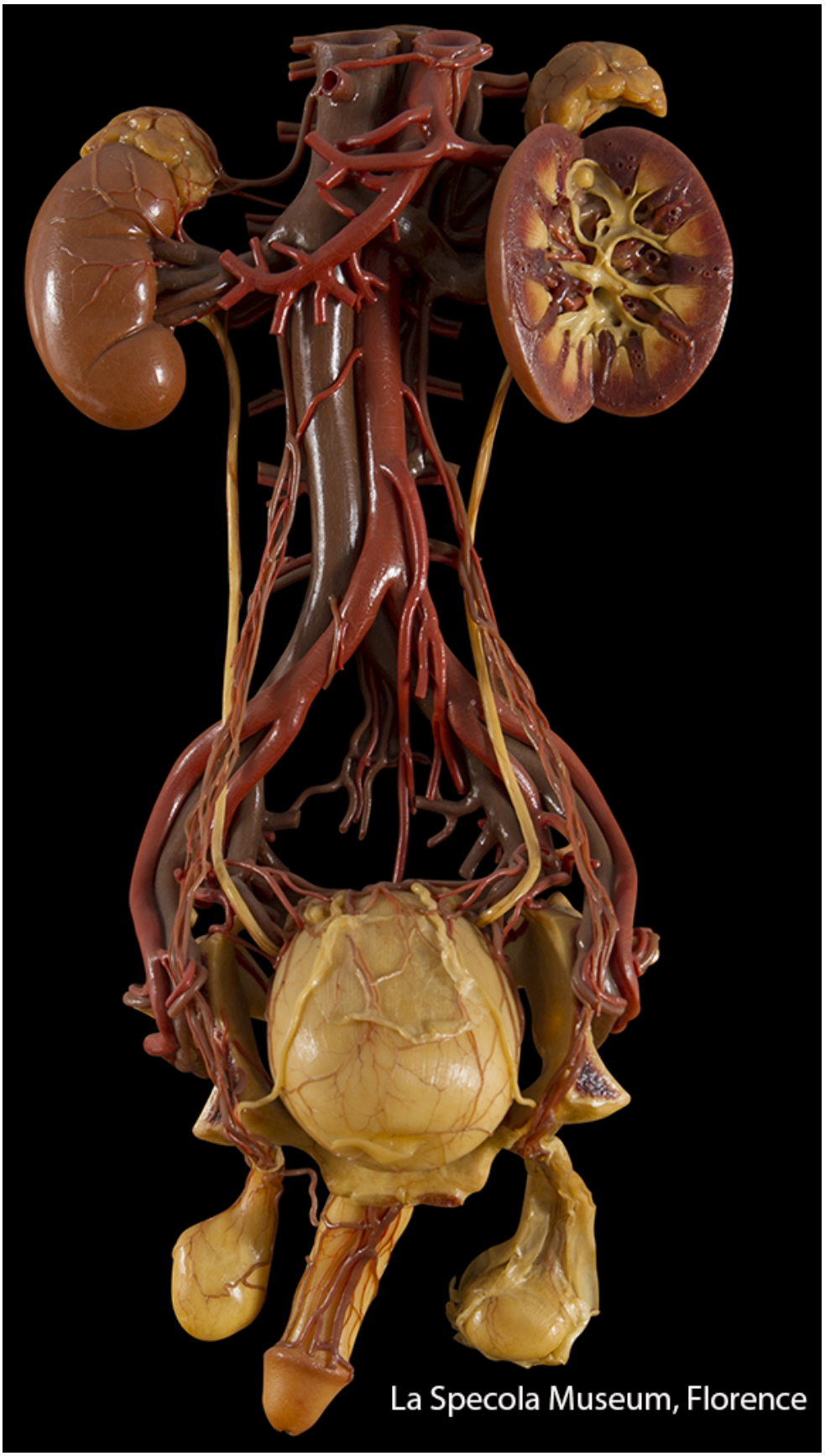
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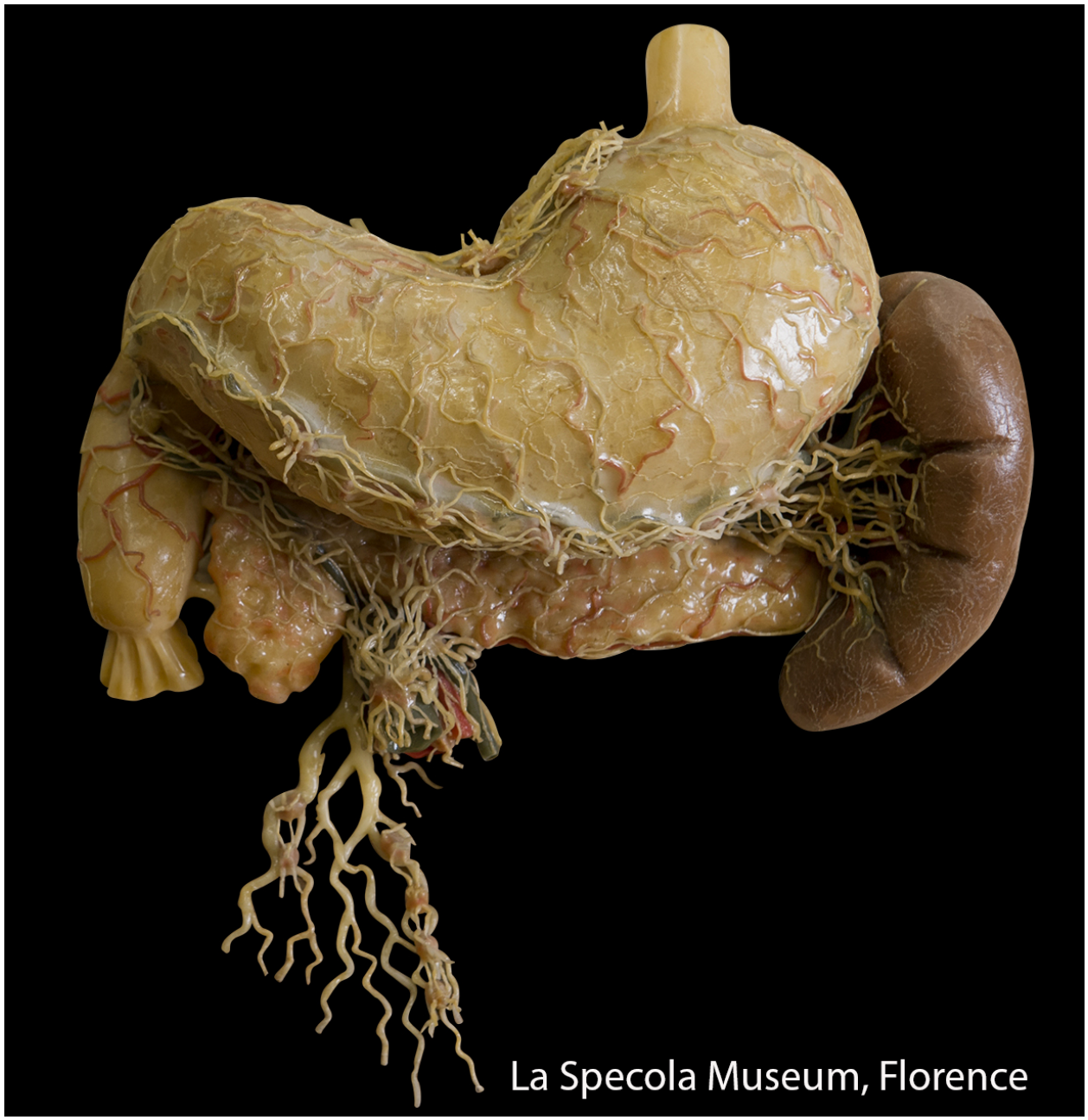
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