

## Overview

### Useful For

Confirming a diagnosis of spinal muscular atrophy due to nucleotide variants in *SMN1* gene

Second-tier carrier screening when there is a family history of spinal muscular atrophy, but an affected individual is not available for testing, or when disease-causing variants are unknown

Second-tier carrier screening for the reproductive partner of a known SMA carrier

### Reflex Tests

Test Id	Reporting Name	Available Separately	Always Performed
CULFB	Fibroblast Culture for Genetic Test	Yes	No

### Genetics Test Information

Testing includes full gene sequencing of the *SMN1* gene.

### Testing Algorithm

For skin biopsy or cultured fibroblast specimens, fibroblast culture testing will be performed at an additional charge. If viable cells are not obtained, the client will be notified.

For more information see [Inherited Motor Neuron Disease and Dementia Testing Algorithm](#)

### Special Instructions

- [Molecular Genetics: Congenital Inherited Diseases Patient Information](#)
- [Informed Consent for Genetic Testing](#)
- [Blood Spot Collection Card-Spanish Instructions](#)
- [Blood Spot Collection Card-Chinese Instructions](#)
- [Inherited Motor Neuron Disease Testing and Dementia Algorithm](#)
- [Informed Consent for Genetic Testing \(Spanish\)](#)
- [Blood Spot Collection Instructions](#)

### Method Name

Polymerase Chain Reaction (PCR) followed by DNA Sequencing

### NY State Available

Yes

## Specimen

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**Specimen Type**

Varies

**Ordering Guidance**

This is **not** the preferred genetic test for carrier screening or diagnosis in individuals with suspicion of spinal muscular atrophy (SMA). For these situations, order SMNCS / Spinal Muscular Atrophy Carrier Screening, Deletion/Duplication Analysis, Varies or SMNDX / Spinal Muscular Atrophy Diagnostic Assay, Deletion/Duplication Analysis, Varies.

This test is appropriate for second-tier carrier screening following SMNCS / Spinal Muscular Atrophy Carrier Screening, Deletion/Duplication Analysis, Varies when:

- There is a family history of SMA, but an affected individual is not available for testing
- The disease-causing variants are unknown
- Testing the reproductive partner of a known SMA carrier

**Shipping Instructions**

Specimen preferred to arrive within 96 hours of collection.

**Specimen Required**

**Patient Preparation:** A previous bone marrow transplant from an allogenic donor will interfere with testing. Call 800-533-1710 for instructions for testing patients who have received a bone marrow transplant.

**Submit only 1 of the following specimens:**

**Specimen Type:** Whole blood

**Container/Tube:**

**Preferred:** Lavender top (EDTA) or yellow top (ACD)

**Acceptable:** Any anticoagulant

**Specimen Volume:** 3 mL

**Collection Instructions:**

1. Invert several times to mix blood.
2. Send whole blood specimen in original tube. **Do not aliquot.**

**Specimen Stability Information:** Ambient (preferred)/Refrigerated

**Specimen Type:** Cultured fibroblasts

**Container/Tube:** T-75 or T-25 flask

**Specimen Volume:** 1 Full T-75 or 2 full T-25 flasks

**Specimen Stability Information:** Ambient (preferred)/Refrigerated <24 hours

**Additional Information:** A separate culture charge will be assessed under CULFB / Fibroblast Culture for Biochemical or Molecular Testing. An additional 3 to 4 weeks is required to culture fibroblasts before genetic testing can occur.

**Supplies:** Fibroblast Biopsy Transport Media (T115)

**Specimen Type:** Skin biopsy

**Container/Tube:** Sterile container with any standard cell culture media (eg, minimal essential media, RPMI 1640). The solution should be supplemented with 1% penicillin and streptomycin.).

**Specimen Volume:** 4-mm punch

**Specimen Stability Information:** Refrigerated (preferred)/Ambient

**Additional Information:** A separate culture charge will be assessed under CULFB / Fibroblast Culture for Biochemical or Molecular Testing. An additional 3 to 4 weeks is required to culture fibroblasts before genetic testing can occur.

**Supplies:** Card - Blood Spot Collection (Filter Paper) (T493)

**Specimen Type:** Blood spot

**Container/Tube:**

**Preferred:** Collection card (Whatman Protein Saver 903 Paper)

**Acceptable:** PerkinElmer 226 (formerly Ahlstrom 226) filter paper or blood spot collection card

**Specimen Volume:** 5 Blood spots

**Collection Instructions:**

1. An alternative blood collection option for a patient older than 1 year of age is fingerstick. See [How to Collect Dried Blood Spot Samples](#) via fingerstick.
2. Let blood dry on the filter paper at ambient temperature in a horizontal position for a minimum of 3 hours.
3. Do not expose specimen to heat or direct sunlight.
4. Do not stack wet specimens.
5. Keep specimen dry.

**Specimen Stability Information:** Ambient (preferred)/Refrigerated

**Additional Information:**

1. Due to lower concentration of DNA yielded from blood spot, it is possible that additional specimen may be required to complete testing.
2. For collection instructions, see [Blood Spot Collection Instructions](#)
3. For collection instructions in Spanish, see [Blood Spot Collection Card-Spanish Instructions](#) (T777)
4. For collection instructions in Chinese, see [Blood Spot Collection Card-Chinese Instructions](#) (T800)

## Forms

1. **New York Clients-Informed consent is required.** Document on the request form or electronic order that a copy is on file. The following documents are available in Special Instructions:

-[Informed Consent for Genetic Testing](#) (T576)

-[Informed Consent for Genetic Testing-Spanish](#) (T826)

2. [Molecular Genetics: Congenital Inherited Diseases Patient Information](#) (T521) in Special Instructions.

## Specimen Minimum Volume

Blood: 1 mL

Blood Spots: 3 punches 3-mm diameter

## Reject Due To

All specimens will be evaluated at Mayo Clinic Laboratories for test suitability.

## Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Varies	Varies		

## Clinical & Interpretive

**Clinical Information**

Spinal muscular atrophy (SMA) is an autosomal recessive neuromuscular disorder characterized by motor neuron degeneration leading to muscular atrophy with progressive paralysis. It is a genetically complex condition that is traditionally divided into 5 subtypes, depending on the age at which symptoms present and the motor milestones that are achieved. Presentation can range from in utero joint contractures and lack of fetal movement (type 0), to loss of ambulation in adolescence or adulthood (type IV). All patients with SMA develop symmetrical loss of muscle control, most commonly affecting proximal muscles. The American College of Medical Genetics and Genomics (ACMG) recommends offering SMA carrier screening to all couples, regardless of race or ethnicity, before conception or early in pregnancy.

The most common form of SMA is associated with the loss of survival motor neuron (SMN) protein, which is encoded by 2 or more genes on chromosome 5. The majority of SMN protein is expressed by the survival motor neuron 1 (*SMN1*) gene, but a small portion of SMN is also contributed by the survival motor neuron 2 (*SMN2*) gene. Indeed, *SMN1* produces more than 90% of SMN protein, while *SMN2* produces less than 10% of residual SMN protein. This occurs because *SMN2* differs from *SMN1* by 5 nucleotides, 1 of which leads to alternative exon 7 splicing, and a reduction of *SMN2* expression. Most individuals have 2 copies of *SMN1*, but individuals with as many as 5 copies of *SMN1* are detected. In addition, individuals may also have 0 to 5 copies of *SMN2*.

SMA is most commonly caused by a homozygous deletion of exon 7 in *SMN1*. However, some patients with this disorder may be compound heterozygotes, with a deletion of 1 copy of *SMN1* and a nucleotide variant in the other allele. The severity of a patient's disease course is associated with the number of copies of *SMN2* that are present, and 3 or more *SMN2* copies are associated with a milder SMA phenotype.

This test aims to specifically identify nucleotide variants in *SMN1* by direct sequencing and to distinguish these nucleotide variants from changes within *SMN2*. However, *SMN1* exon 1 variants are still unable to be distinguished from changes within *SMN2* exon 1.

**Reference Values**

An interpretive report will be provided.

**Interpretation**

All detected alterations are evaluated according to American College of Medical Genetics and Genomics recommendations.<sup>(1)</sup> Variants are classified based on known, predicted, or possible pathogenicity and reported with interpretive comments detailing their potential or known significance.

**Cautions**

Variants detected in *SMN1* exon 1 cannot be distinguished from variants in *SMN2* exon 1. Therefore, additional molecular analyses are required to confirm results in this region.

A small percentage of individuals who are carriers or have a diagnosis of spinal muscular atrophy may have a variant that is not identified by this method (eg, large genomic deletions, promoter alterations). The absence of a variant, therefore, does not eliminate the possibility of positive carrier status or the diagnosis of spinal muscular atrophy. For carrier testing, it is important to first document the presence of an *SMN1* gene variant in an affected family member.

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In some cases, DNA alterations of undetermined significance may be identified.

Rare alterations exist that could lead to false-negative or false-positive results. If results obtained do not match the clinical findings, additional testing should be considered.

Test results should be interpreted in the context of clinical findings, family history, and other laboratory data. Errors in the interpretation of results may occur if information given is inaccurate or incomplete.

### Clinical Reference

1. Richards S, Aziz N, Bale S, et al: Standards and guidelines for the interpretation of sequence variants: a joint consensus recommendation of the American College of Medical Genetics and Genomics and the Association for Molecular Pathology. *Genet Med*. 2015 May;17(5):405-424
2. Wirth B: An update of the mutation spectrum of the survival motor neuron gene (SMN1) in autosomal recessive spinal muscular atrophy (SMA). *Hum Mutat*. 2000;15:228-237
3. Clermont O, Bulet P, Benit P, et al: Molecular analysis of SMA patients without homozygous SMN1 deletions using a new strategy for identification of SMN1 subtle mutations. *Hum Mutat*. 2004;24:417-427
4. Kubo Y, Nishio H, Saito K: A new method for SMN1 and hybrid SMN gene analysis in spinal muscular atrophy using long-range PCR followed by sequencing. *J Hum Genet*. 2015;60: 233-239
5. Prior T, Leach ME, Finanger E: Spinal muscular atrophy. In: Adam MP, Ardinger HH, Pagon RA, et al, eds. *Gene Reviews* [Internet]. University of Washington, Seattle; 2000. Updated November 14, 2019. Accessed September 28, 2020. Available at [www.ncbi.nlm.nih.gov/sites/books/NBK1352/](http://www.ncbi.nlm.nih.gov/sites/books/NBK1352/)
6. The Human Gene Mutation Database (HGMD), Professional version 2017.2 from BIOBASE. A database of germline mutations in genes associated with human inherited disease. Accessed Sep 12, 2017. Available at <https://portal.biobase-international.com/hgmd/pro/start.php>

## Performance

### Method Description

Long-range-PCR of *SMN1* exons 2-8, followed by bidirectional Sanger sequence analysis for nucleotide variants in all protein-coding regions and intron/exon boundaries of *SMN1*. *SMN1* exon 1 is PCR-amplified and bidirectionally Sanger-sequenced.(Unpublished Mayo method)

### PDF Report

No

### Day(s) Performed

Varies

### Report Available

14 to 20 days

### Specimen Retention Time

Whole Blood: 2 weeks (if available); Extracted DNA: 3 months

## Performing Laboratory Location

Rochester

## Fees & Codes

### Fees

- Authorized users can sign in to [Test Prices](#) for detailed fee information.
- Clients without access to Test Prices can contact [Customer Service](#) 24 hours a day, seven days a week.
- Prospective clients should contact their account representative. For assistance, contact [Customer Service](#).

### Test Classification

This test was developed, and its performance characteristics determined by Mayo Clinic in a manner consistent with CLIA requirements. This test has not been cleared or approved by the US Food and Drug Administration.

### CPT Code Information

81336

88233-Tissue culture, skin, or solid tissue biopsy (if appropriate)

88240-Cryopreservation (if appropriate)

### LOINC® Information

Test ID	Test Order Name	Order LOINC® Value
SMN1Z	SMN1 Full Gene Analysis	94221-9

Result ID	Test Result Name	Result LOINC® Value
602754	Result Summary	50397-9
602755	Result	82939-0
602756	Interpretation	69047-9
602757	Additional Information	48767-8
602758	Specimen	31208-2
602759	Source	31208-2
602760	Released By	18771-6