

## Overview

### Useful For

Monitoring effectiveness of dietary therapy in patients with hyperphenylalaninemia

### Genetics Test Information

Defects in phenylalanine hydroxylase (PAH) cause the majority of cases of hyperphenylalaninemia (HPA); however, approximately 2% of infants with HPA have impaired synthesis or recycling of tetrahydrobiopterin (BH4).

Phenylketonuria: Evaluation of patients with hyperphenylalaninemia or monitoring effectiveness of dietary therapy. This test is not sufficient follow-up for abnormal newborn screening results, because other causes of HPA (eg, BH4 deficiency) cannot be excluded by this test alone.

Tyrosinemia, type I: For medical management

### Method Name

Liquid Chromatography Tandem Mass Spectrometry (LC-MS/MS)

### NY State Available

Yes

## Specimen

### Specimen Type

Plasma

### Necessary Information

1. Patient's age is required.
2. Include family history, clinical condition (asymptomatic or acute episode), diet, and drug therapy information.

### Specimen Required

**Patient Preparation:** Patient should fast overnight (8-12 hour fast); infants should have specimen collected before next feeding (4 hour fast)

#### Collection Container/Tube:

**Preferred:** Green top (Sodium heparin)

**Acceptable:** Green top (Lithium heparin), lavender top (EDTA)

**Submission Container/Tube:** Plastic vial

**Specimen Volume:** 0.5 mL

#### Collection Instructions:

1. Centrifuge and aliquot plasma into a plastic vial.
2. Send plasma frozen.

Forms

[If not ordering electronically, complete, print, and send a Biochemical Genetics Test Request](#) (T798) with the specimen.

Specimen Minimum Volume

0.1 mL

Reject Due To

|                 |    |
|-----------------|----|
| Gross hemolysis | OK |
| Gross lipemia   | OK |
| Gross icterus   | OK |

Specimen Stability Information

| Specimen Type | Temperature        | Time    | Special Container |
|---------------|--------------------|---------|-------------------|
| Plasma        | Frozen (preferred) | 14 days |                   |
|               | Refrigerated       | 14 days |                   |

Clinical & Interpretive

Clinical Information

Phenylketonuria (PKU) is the most frequent inherited disorder of amino acid metabolism (about 1:10,000-1:15,000) and was the first successfully treated inborn error of metabolism. It is inherited in an autosomal recessive manner and is caused by a defect in the enzyme phenylalanine hydroxylase (PAH), which converts the essential amino acid phenylalanine to tyrosine. Deficiency of PAH results in decreased levels of tyrosine and an accumulation of phenylalanine in blood and tissues. If left untreated, PKU leads to severe brain damage with intellectual impairment, behavior abnormalities, seizures, and spasticity. The level of enzyme activity differentiates classic PKU (PAH activity <1%) from other milder forms; however, all are characterized by increased levels of phenylalanine (hyperphenylalaninemia). Treatment includes the early introduction of a diet low in phenylalanine.

Tetrahydrobiopterin (BH4) is a cofactor of PAH as well as tyrosine and tryptophan hydroxylase. Approximately 2% of patients with hyperphenylalaninemia have a deficiency of BH4, which causes a secondary deficit of the neurotransmitters, dopamine and serotonin. There are 4 autosomal recessive disorders associated with BH4 deficiency plus hyperphenylalaninemia: guanosine triphosphate cyclohydrolase deficiency; 6-pyruvoyl tetrahydropterin synthase deficiency; dihydropteridine reductase deficiency; and pterin-4 alpha carbinolamine dehydratase (PCD) deficiency. This group of disorders, with the exception of PCD, is characterized by progressive dystonia, truncal hypotonia, extremity hypertonia, seizures, and intellectual disability though milder presentations exist. PCD has no symptoms other than transient alterations in tone. Treatment may include administration of BH4, L-dopa (and carbidopa) 5-hydroxytryptophan supplements, and a low phenylalanine diet.

Tyrosine is a nonessential amino acid, which is derived from dietary sources, the hydroxylation of phenylalanine, or protein breakdown. Primary PKU and secondary (defects of BH4 metabolism) hyperphenylalaninemia can cause abnormally low levels of tyrosine. Measurement of the phenylalanine:tyrosine ratio is helpful in monitoring appropriate

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dietary intake.

**Reference Values****PHENYLALANINE**

Premature: 98-213 nmol/mL

0-31 days: 38-137 nmol/mL

1-24 months: 31-75 nmol/mL

2-18 years: 26-91 nmol/mL

> or =19 years: 35-85 nmol/mL

**Conversion Formulas:**

Result in mg/dL x 60.5=result in nmol/mL

Result in nmol/mL x 0.0165=result in mg/dL

**TYROSINE**

Premature: 147-420 nmol/mL

0-31 days: 55-147 nmol/mL

1-24 months: 22-108 nmol/mL

2-18 years: 24-115 nmol/mL

> or =19 years: 34-112 nmol/mL

**Conversion Formulas:**

Result in mg/dL x 55.2=result in nmol/mL

Result in nmol/mL x 0.0181=result in mg/dL

**Interpretation**

The quantitative results of phenylalanine and tyrosine with age-dependent reference values are reported without added interpretation. When applicable, reports of abnormal results may contain an interpretation based on available clinical interpretation.

A phenylalanine:tyrosine ratio higher than 3 is considered abnormal.

**Cautions**

This test is not sufficient to establish a diagnosis of hyperphenylalaninemia.

**Clinical Reference**

1. Mitchell GA, Grompe M, Lambert M, Tanguay RM. Hypertyrosinemia. In: Valle DL, Antonarakis S, Ballabio A, Beaudet AL, Mitchell GA. eds. The Online Metabolic and Molecular Bases of Inherited Disease. McGraw Hill; 2019. Accessed October 2, 2024. Available at <https://ommbid.mhmedical.com/content.aspx?bookid=2709&sectionid=225082825>
2. Donlon J, Sarkissian C, Levy H, Scriver CR. Hyperphenylalaninemia: Phenylalanine hydroxylase deficiency. In: Valle DL, Antonarakis S, Ballabio A, Beaudet AL, Mitchell GA, eds. The Online Metabolic and Molecular Bases of Inherited Disease. McGraw-Hill; 2019. Accessed October 2, 2024. Available at <https://ommbid.mhmedical.com/content.aspx?bookid=2709&sectionid=225081923>
3. Burgard P, Luo X, Hoffmann GF. Phenylketonuria. In: Sarafoglou K, Hoffman GF, Roth KS, eds. Pediatric Endocrinology and Inborn Errors of Metabolism. McGraw-Hill Medical Division; 2009:163-168
4. Blau N, Thony B. Hyperphenylalanemias: Disorders of tetrahydrobiopterin metabolism. In: Sarafoglou K, Hoffmann GF,

Roth KS, eds. Pediatric Endocrinology and Inborn Errors of Metabolism. McGraw-Hill Medical Division; 2009:169-175

## Performance

### Method Description

This method quantifies phenylalanine (Phe) and tyrosine (Tyr) using stable isotope-labeled internal standards (IS): d5-Phe and d4-Tyr. Phe and Tyr are extracted from plasma. The supernatant is diluted and then introduced into the tandem mass spectrometer. The concentration of Phe and Tyr are established by comparison of the ion intensity with that of the IS.(Unpublished Mayo method)

### PDF Report

No

### Day(s) Performed

Monday through Friday

### Report Available

2 to 4 days

### Specimen Retention Time

2 weeks

### Performing Laboratory Location

Mayo Clinic Laboratories - Rochester Main Campus

## 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. It has not been cleared or approved by the US Food and Drug Administration.

### CPT Code Information

- 84030 Phenylalanine
- 84510 Tyrosine
- 82542 (if appropriate for government payers)

### LOINC® Information

| Test ID | Test Order Name               | Order LOINC® Value |
|---------|-------------------------------|--------------------|
| PKU     | Phenylalanine and Tyrosine, P | 101402-6           |

| Result ID | Test Result Name | Result LOINC® Value |
|-----------|------------------|---------------------|
| 8380      | Phenylalanine, P | 14875-9             |
| 8627      | Tyrosine, P      | 20660-7             |