MAYO CLINIC LABORATORIES

Test Definition: LBCS

Labile Bound Copper, Serum

Overview

Useful For

May be useful in the evaluation of copper-related disorders, including Wilson disease

Additional Tests

Test Id	Reporting Name	Available Separately	Always Performed
CUS1	Copper, S	Yes	Yes

Testing Algorithm

After a labile-bound copper serum result is obtained, a total copper serum test will be performed at an additional charge. The labile-bound copper concentration will be divided by the total copper concentration to calculate the labile-bound copper fraction result.

Special Instructions

- Metals Analysis Specimen Collection and Transport

Method Name

Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

NY State Available

Yes

Specimen

Specimen Type

Serum

Ordering Guidance

If CUS1 / Copper, Serum is ordered with this test, it will be canceled, as copper testing will be automatically added as a part of this test order.

Specimen Required

Patient Preparation: High concentrations of gadolinium and iodine are known to potentially interfere with most inductively coupled plasma mass spectrometry-based metal tests. If either gadolinium- or iodine-containing contrast media has been administered, **a specimen should not be collected for at least 96 hours**.

Supplies:

-Metal Free Specimen Vial (T173)

-Metal Free B-D Tube (No Additive), 6 mL (T184)

Collection Container/Tube: 6-mL Plain, royal blue-top Vacutainer plastic trace element blood collection tube

Submission Container/Tube: 7-mL Metal-free, screw-capped, polypropylene vial
Specimen Volume: 0.75 mL serum
Collection Instructions:
1. For complete instructions, see Metals Analysis Specimen Collection and Transport.
2. Allow the specimen to clot for 30 minutes; then centrifuge the specimen to separate serum from the cellular fraction.
3. Remove the stopper. Carefully pour specimen into metal-free, polypropylene vial, avoiding transfer of the cellular components of blood. **Do not** insert a pipet into the serum to accomplish transfer, and **do not** ream the specimen with a wooden stick to assist with serum transfer.
4. Freeze sample on dry ice immediately after pouring off the serum.

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

Specimen Minimum Volume
Serum: 0.5 mL

Reject Due To

Gross hemolysis	OK
Gross lipemia	OK
Gross icterus	Reject

Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Serum	Frozen	28 days	METAL FREE

Clinical & Interpretive

Clinical Information
Copper (Cu) is an important trace element that is associated with a number of metalloproteins. Copper in biological material is complexed with proteins, peptides, and other organic ligands. The majority of copper in plasma is bound to the enzyme ceruloplasmin, a copper-dependent multifunction oxidase enzyme. Up to 90% of copper exported from the liver into peripheral blood is tightly protein bound. The remaining copper fraction is often referred to as "free" copper, however a more accurate description is labile bound copper (LBC), as it is not truly circulating freely but is loosely bound to various smaller proteins, including albumin, transcuprein, tetrapeptides, and other amino acids.

This test involves measurement of both the LBC concentration and total copper. The LBC will be divided by the measured total copper concentration to calculate an LBC fraction result. The LBC fraction (%) may be more useful than LBC in some disease states, such as Wilson disease, as it represents the fraction of LBC normalized against potential variation in total copper burden.

Low serum copper, most often due to excess iron or zinc ingestion and infrequently due to dietary copper deficit, may

result in altered growth and in impaired erythropoiesis. Low total serum copper is also observed in hepatolenticular degeneration (Wilson disease) due to a decrease in the synthesis of ceruloplasmin and allelic variances in cellular metal ion transporters. In Wilson disease, the albumin-bound copper may actually be increased, but ceruloplasmin-bound copper is low, resulting in low serum copper. However, during the acute phase of Wilson disease (fulminant hepatic failure), ceruloplasmin and copper levels may be normal; in this circumstance, hepatic inflammation causes increased release of ceruloplasmin. It is useful to relate the degree of liver inflammation to ceruloplasmin and copper (see the following discussion on hypercupremia). Significant hepatic inflammation with normal ceruloplasmin and copper suggest acute Wilson disease.

As WD is characterized by a loss of ceruloplasmin-copper binding function, the concentration of non-ceruloplasmin bound labile copper (NCC) is an attractive target as a diagnostic aid. NCC has been historically estimated by the following formula: NCC = total serum copper (mcg/dL) - [3.15 x ceruloplasmin (mcg/dL)]. This calculated estimate has limitations, as it is difficult to directly measure ceruloplasmin, and assumes that all available ceruloplasmin is fully saturated with copper. As such, a clinical assay that can directly quantify the proportion of "free" or labile bound (LBC fraction) of total copper in serum may be preferable. While measurement of LBC fraction has been shown to be a promising diagnostic tool for Wilson disease, it may be applicable to other copper-related disorders as well.

Additional disorders associated with decreased serum copper concentrations include malnutrition, hypoproteinemia, malabsorption, nephrotic syndrome, Menkes disease, copper toxicity, and megadosing of zinc-containing vitamins (zinc interferes with normal copper absorption from the gastrointestinal [GI] tract). Hypercupremia is found in primary biliary cholangitis (formerly primary biliary cirrhosis), primary sclerosing cholangitis, hemochromatosis, malignant diseases (including leukemia), thyrotoxicosis, and various infections. Serum copper concentrations are also elevated in patients taking contraceptives or estrogens as well as during pregnancy. Since the GI tract effectively excludes excess copper, it is the GI tract that is most affected by copper ingestion. Increased copper serum concentration, LBC copper, and LBC fraction alone do not directly indicate copper toxicity.

Reference Values

Labile Bound Copper: <105 ng/mL

Labile Bound Copper Fraction:
Males: <10.5 %
Females: <8.1 %

Copper, Total:
0-2 months: 40-140 mcg/dL
3-6 months: 40-160 mcg/dL
7-9 months: 40-170 mcg/dL
10-12 months: 80-170 mcg/dL
13 months-10 years: 80-180 mcg/dL
11-17 years: 75-145 mcg/dL
Males:
> or =18 years: 73-129 mcg/dL
Females:
> or =18 years: 77-206 mcg/dL

Interpretation

This test measures the labile bound copper (LBC) in serum and calculates the fraction (%) of LBC to total copper (LBC fraction).

Serum copper results below the normal range and LBC fractions above the normal range are associated with Wilson disease. Abnormal total copper and LBC fraction may also be associated with a variety of other copper-related disorders (see Clinical Information).

Cautions

No significant cautionary statements

Clinical Reference

1. Woimant F, Djebrani-Oussedik N, Poujois A. New tools for Wilson's disease diagnosis: exchangeable copper fraction. Ann Transl Med. 2019;7(Suppl 2):S70. doi:10.21037/atm.2019.03.02
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4. Shribman S, Marjot T, Sharif A, et al. Investigation and management of Wilson's disease: a practical guide from the British Association for the Study of the Liver. Lancet Gastroenterol Hepatol. 2022;7(6):560-575
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6. Alman B, Fay M, Antezana A, et al. Toxicological Profile for Copper. ATSDR; 2022. Revised October 2024. Accessed September 5, 2025. Available at www.atsdr.cdc.gov/toxprofiles/tp132.pdf
7. Bitzer AC, Fox J, Day PL, et al. Establishment of a labile bound copper reference interval in a healthy population via an inductively coupled plasma mass spectrometry dual filtration-based assay. Arch Pathol Lab Med. 2024;148(7):818-827. doi:10.5858/arpa.2023-0259-OA. PMID: 37870242
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9. Marino Z, Schilsky ML Wilson disease: Novel diagnostic and therapeutic approaches. Semin Liver Dis. 2025;45(2):221-235. doi:10.1055/a-2460-8999
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11. European Association for Study of Liver. EASL Clinical Practice Guidelines: Wilson's disease. J Hepatol. 2012;56(3):671-685. doi:10.1016/j.jhep.2011.11.007

Performance

Method Description

Total copper is analyzed by inductively coupled plasma mass spectrometry.(Unpublished Mayo method)

The labile bound copper fraction of serum is isolated from total copper through a series of filtration and chelation steps. Labile bound copper is then analyzed by inductively coupled plasma mass spectrometry.(Bitzer AC, Fox J, Day PL, et al. Establishment of a labile bound copper reference interval in a healthy population via an inductively coupled plasma

mass spectrometry dual filtration-based assay. Arch Pathol Lab Med. 2024;148[7]:818-827. doi:10.5858/arpa.2023-0259-OA)

PDF Report
No

Day(s) Performed
Wednesday

Report Available
7 to 15 days

Specimen Retention Time
14 days

Performing Laboratory Location
Mayo Clinic Laboratories - Rochester Superior Drive

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
82525

LOINC® Information

Test ID	Test Order Name	Order LOINC® Value
LBCS	Labile Bound Copper, S	105459-2

Result ID	Test Result Name	Result LOINC® Value
620895	Labile Bound Copper, S	96257-1
620896	Labile Bound Copper Fraction	96463-5