



## THYROID TESTS

# Decoding Your Thyroid Tests and Results

Wondering about your thyroid test results? Learn about each test and what low, optimal, and high results may mean so you can work with your doctor to choose appropriate treatment.

	Name of Test	Optimal Range
1	Thyroid stimulating hormone (TSH)	0.3 – 4 mU/L
2	Free thyroxine (Free T4)	0.7 – 1.9 ng/dL
3	Free triiodothyronine (Free T3)	230 – 619 pg/dL
4	Radioactive iodine uptake (RAIU) at 6 hours	3 – 16%
	Radioactive iodine uptake (RAIU) at 24 hours	8 – 25%
5	TRH stimulation test	5 – 30 mU/L
6	Thyroglobulin antibody	0 – 4 IU/mL
7	Thyroid peroxidase antibodies (TPO)	0 – 9 IU/mL
8	Thyrotropin receptor antibodies (TRAb)	0 – 1.75 IU/mL
9	Reverse T3	12 – 24 ng/dL
10	Total thyroxine (T4)	4 – 12 ug/dL
11	Total triiodothyronine (T3)	80 – 180 ng/dL
12	Free thyroxin index (FTI)	4.8 – 12.7 mcg/dL
13	T3 resin uptake (T3RU)	25 – 50%
14	Thyroid binding globulin (TBG) measured by electrophoresis	10 – 24 mg/dL
	Thyroid binding globulin (TBG) measured by radioimmunoassay	1.3 - 2 mg/dL



THYROID TESTS

1

## Thyroid Stimulating Hormone

**Optimal range: 0.3 – 4 mU/L**  
**Borderline high range: 4 – 10 mU/L**

Thyroid stimulating hormone (TSH) regulates the amount of thyroid hormone produced by the thyroid gland. TSH levels increase (stimulating the thyroid gland) when thyroid hormone levels fall, and they decrease (reducing thyroid stimulation) when thyroid hormone levels increase. The TSH test is probably the most important thyroid test, often used to screen for thyroid disease and monitor the effectiveness of treatment in a person who has thyroid disease.

However, there is ongoing controversy over the upper limit of normal for the TSH test. Most authorities, including the American Thyroid Association, use 4.0 mU/L. However, in 2013, the National Academy of Clinical Biochemistry recommended that the upper limit should be reduced to 2.5 mU/L. Using this lower value would greatly increase the number of people diagnosed with hypothyroidism, and most experts have rejected this recommendation.

### Low Results

TSH levels that are below normal indicate hyperthyroidism. If the TSH was measured as a screening test, further testing is indicated, with at least a free T4 test. Other tests that may be helpful include free T3, thyroid peroxidase antibody (TPO) levels, thyroglobulin antibody levels, thyrotropin receptor antibody levels (TRAb), and/or a radioactive iodine uptake (RAIU). TSH levels are also in the low range if a person with hypothyroidism is taking too much thyroid hormone replacement medication, and may mean that a lower dose is needed.

### Optimal Results

TSH levels in the optimal range indicate that the thyroid gland is producing the right amount of thyroid hormone. In a person taking thyroid replacement therapy, normal TSH levels are often used as an indication that the right amount of medication is being prescribed.

### High Results

TSH levels that are higher than normal indicate hypothyroidism. If the TSH was measured as a screening test, further testing should be done with a free T4 test and possibly free T3, thyroid peroxidase antibody (TPO), and thyroglobulin antibody levels. In a person taking thyroid replacement medication, an elevated TSH level generally indicates that a higher dosage is needed.



THYROID TESTS

2

## Free Thyroxine (Free T4)

**Optimal range: 0.7 – 1.9 ng/dL**

Thyroxine, or T4, is one of the two important thyroid hormones. Almost all of the T4 in the blood (99.97%) is bound to blood proteins, but only the unbound T4 is active. The free T4 test measures the tiny amount of circulating T4 that is unbound, active T4.

The advantage to measuring free T4 is that this test is not affected by changes in the thyroid-binding blood proteins. In most people, the free T4 test can be combined with the TSH test to assess the overall status of the thyroid gland.

### Low Results

Reduced blood levels of free T4 usually indicate hypothyroidism. When combined with an elevated TSH level, a low free T4 definitively indicates hypothyroidism. When free T4 is low, it is sometimes useful to measure thyroid peroxidase antibody (TPO) or thyroglobulin antibody levels to confirm Hashimoto thyroiditis.

### Optimal Results

A free T4 level in the optimal range usually indicates normal thyroid gland function. A free T4 level in the normal range is usually accompanied by a TSH level that is also in the normal range. When combined with an elevated TSH level, a normal free T4 may indicate subclinical hypothyroidism. When combined with a low TSH level, a normal free T4 may be an indicator of subclinical hyperthyroidism.

### High Results

An elevated free T4 test indicates hyperthyroidism and is virtually always accompanied by a low TSH level. Measuring thyroid peroxidase antibody (TPO) or thyroglobulin antibody levels may help to confirm Graves' disease. If Graves' disease is suspected, it is often helpful to measure thyrotropin receptor antibodies (TRAb) as well.

3

## Free Triiodothyronine (Free T3)

**Optimal range: 230 – 619 ng/dL**

Thyroxine, or T4, is one of the two important thyroid hormones. Almost all of the T4 in the blood (99.97%) is bound to blood proteins, but only the unbound T4 is active. The free T4 test measures the tiny amount of circulating T4 that is unbound, active T4.

The advantage to measuring free T4 is that this test is not affected by changes in the thyroid-binding blood proteins. In most people, the free T4 test can be combined with the TSH test to assess the overall status of the thyroid gland.

### Low Results

Reduced free T3 levels are virtually always accompanied by reduced free T4 levels and high TSH levels and indicate hypothyroidism. It is sometimes useful to measure thyroid peroxidase antibody (TPO) or thyroglobulin antibody levels to confirm Hashimoto thyroiditis.

### Optimal Results

Free T3 levels in the normal range indicate normal thyroid function and is usually accompanied by normal free T4 and normal TSH levels. A normal free T3 level with a low TSH level might indicate subclinical hypothyroidism. A normal free T3 level with an elevated TSH level might indicate subclinical hyperthyroidism.

### High Results

An elevated free T3 test indicates hyperthyroidism and is virtually always accompanied by elevated free T4 and low TSH levels. Measuring thyroid peroxidase antibody (TPO) or thyroglobulin antibody levels may help to confirm Graves' disease. If Graves' disease is suspected, it is often helpful to measure Thyrotropin receptor antibodies (TRAb) as well.



THYROID TESTS

4

### Radioactive Iodine Uptake (RAIU) at 6 or 24 hours

The radioactive iodine uptake (RAIU) test measures the uptake of iodine by the thyroid gland, which can help to determine the cause of hyperthyroidism. In this test, a small dose of radioactive iodine is given by mouth, and later (usually after 24 hours) the gland is scanned to estimate how much of the iodine has been taken up by the thyroid.

**Optimal range at 6 hours:**  
3 – 16%

**Optimal range at 24 hours:**  
8 – 25%

**Low Results**

A reduced or optimal iodine uptake in a person with hyperthyroidism often indicates subacute thyroiditis. In subacute thyroiditis, elevated blood levels of thyroid hormone often result from inflammatory destruction of the thyroid gland, and the subsequent release of T4 and T3 into the circulation, rather than from the overproduction of thyroid hormone.

A low or optimal uptake in a person with hyperthyroidism can also mean that the subject is surreptitiously or unknowingly ingesting thyroid hormone; or it can indicate struma ovarii, a condition in which thyroid hormone is produced in the pelvis rather than the neck.

**Optimal Results**

**High Results**

In a person with hyperthyroidism, a high iodine uptake is the most common result and indicates that the thyroid gland is working overtime to produce too much thyroid hormone. Most typically, this is seen with Grave's disease.

5

### TRH Stimulation Test

**Optimal range: 5 – 30 mU/L**

In some rare cases, hypothyroidism is caused by disease of the pituitary gland or the hypothalamus instead of disease of the thyroid gland itself. When this happens, TSH levels are low despite the presence of hypothyroidism. To test whether the pituitary is able to release TSH normally, the TRH stimulation test may be used.

Normally, thyrotropin-releasing hormone (TRH) is secreted by the hypothalamus in response to reduced thyroid hormone levels and its job is to further stimulate the pituitary gland to release TSH. With the TRH stimulation test, an intravenous dose of TRH is administered, and subsequent TSH levels are measured.

Ideally, for a normal response, TSH levels should rise substantially within 20 minutes to 5-30 mU/L and drop again within 60 minutes after TRH administration. However, the normal response to TRH administration is highly variable, often making this test difficult to interpret.

**Low Results**

If TSH levels do not increase as expected, pituitary disease (or sometimes, hypothalamic disease) should be strongly suspected as a likely cause of hypothyroidism. Generally, an MRI scan of the hypothalamus/pituitary region of the brain should be the next step.

**Optimal Results**

A normal or high increase in TSH levels is an indication that the pituitary gland is able to release TSH normally, and that pituitary disease is not the cause of hypothyroidism.

**High Results**



THYROID TESTS

6

### Thyroglobulin Antibody

Optimal range: 0 – 4 IU/mL

Both Graves' disease (which typically produces hyperthyroidism) and Hashimoto disease (which typically produces hypothyroidism) are autoimmune diseases. One of the manifestations of these autoimmune thyroid conditions is that they often produce antibodies to thyroglobulin, the major thyroid-binding protein within the thyroid gland. The presence of thyroglobulin antibodies is consistent with autoimmune thyroid disease and can be helpful in confirming the diagnosis.

#### Optimal Results

Only about 50% of people with Hashimoto disease and about 25% of people with Graves' disease will have detectable thyroglobulin antibodies, so an optimal level (below 4 IU/mL) is not helpful in making a diagnosis of autoimmune thyroid disease.

#### High Results

Levels of thyroglobulin antibodies above the threshold are consistent with Hashimoto or Graves' disease and can be helpful in confirming the diagnosis. Thyroid cancer can also produce elevated thyroglobulin antibodies.

7

### Thyroid Peroxidase Antibodies (TPO)

Optimal range: 0 – 9 IU/mL

Thyroid peroxidase is an enzyme used in the synthesis of thyroid hormone. In autoimmune forms of thyroid disease—especially Hashimoto disease and Graves' disease—antibodies may be formed to thyroid peroxidase. The presence of these TPO antibodies can help to confirm the diagnosis in patients with suspected autoimmune thyroid disease.

#### Optimal Results

Because some people with autoimmune thyroid disease do not have detectable levels of TPO antibody, an optimal blood level (anything below 9 IU/mL) is not helpful in confirming or ruling out a diagnosis.

#### High Results

Levels of TPO antibodies above the threshold are consistent with Hashimoto or Graves' disease and can be helpful in confirming the diagnosis. About 90% of people with Hashimoto thyroiditis, and about 70% of those with Graves' disease, will have TPO antibodies. In people with subclinical hypothyroidism, the presence of TPO antibodies tends to indicate that overt hypothyroidism is likely to occur at some point.



THYROID TESTS

8

### Thyrotropin Receptor Antibodies (TRAb)

Optimal range: 0 – 1.75 ng/dL

Graves' disease is an autoimmune disease that may produce antibodies to the thyrotropin receptors (TRAb), located on the thyroid gland. TRAb, like TSH itself, often will stimulate the thyroid gland to produce thyroid hormone. So, unlike other thyroid-related antibodies, TRAb is not merely a passive marker but may contribute to the disease itself by increasing hyperthyroidism. Measuring TRAb not only helps to confirm the diagnosis of Graves' disease but also can help to predict the severity of Graves' disease.

Optimal Results

A TRAb level below the cutoff value strongly suggests that, if thyroid disease is present, it is likely to be some condition other than Graves' disease.

High Results

An elevated TRAb level (above the optimal cutoff) is highly sensitive and specific for Graves' disease. In people treated with antithyroid drugs for Graves' disease, persistently elevated TRAb levels predict that a relapse is likely. In women treated for Graves' disease with currently normal thyroid function, elevated TRAb levels are associated with an increased risk of neonatal hyperthyroidism.

9

### Reverse T3

Optimal range: 12 – 24 ng/dL

Reverse T3 is an inactive form of T3 that is normally produced in the thyroid gland as a by-product of thyroid hormone formation. During periods of certain debilitating non-thyroid illnesses that reduce overall body metabolism, thyroid hormone production is reduced and more thyroid hormone than normal is shunted to the production of reverse T3. In these cases, measurements of blood T4 and T3 may be low, even though actual hypothyroidism is not present.

Measuring reverse T3 levels has been recommended by some as a way of differentiating actual thyroid disease from a manifestation of non-thyroid disease—a condition that has been called "euthyroid sick."

Low Results

Normally, reverse T3 levels track with T4 levels, so a reverse T3 level in the low range is seen in hypothyroidism.

Optimal Results

A normal reverse T3 level is typical in a person with normal thyroid function.

High Results

Normally, reverse T3 levels track with T4 levels. So a reverse T3 level in the high range is seen in hyperthyroidism. However, elevated reverse T3 is also seen in a person who is euthyroid sick, that is, in someone with a chronic disease that suppresses the body's metabolism. Such illnesses may include severe infection, significant burns, liver disease, severe trauma, and starvation.



THYROID TESTS

10

### Total Thyroxine (T4)

Optimal range: 4 – 12 IU/mL

Thyroxine, or T4, is one of the two important thyroid hormones. Almost all of the T4 in the blood (99.97%) is bound to blood proteins, but only the unbound T4 is active. Because total T4 levels can be affected by changes in blood proteins, this test is not considered to be as accurate in diagnosing thyroid problems as the free T4 test, which measures only the unbound, active T4. As a result, measurement of free T4 has largely supplanted the total T4 test.

#### Low Results

A reduced blood level of total T4 is usually an indicator of hypothyroidism. However, total T4 can also be reduced in the absence of hypothyroidism if the amount of thyroid binding proteins in the blood are low. Measuring free T4 and TSH levels usually clarify the diagnosis.

#### Optimal Results

A normal total T4 level is an indicator of normal thyroid hormone levels, but it must be interpreted in light of the TSH test and taking into consideration the amount of thyroid-binding protein in the blood.

#### High Results

An elevated blood level of total T4 usually indicates hyperthyroidism. However, total T4 levels can also be increased with conditions that increase the amount of thyroid binding proteins in the blood, such as pregnancy or taking oral contraceptives. Measuring free T4 and TSH levels usually clarify the diagnosis.

11

### Total Triiodothyronine (T3)

Optimal range: 80 – 180 ng/dL

Triiodothyronine, or T3, is one of the two important thyroid hormones. Most of the T3 in the blood (99.7%) is bound to blood proteins, but only the unbound T3 is active. Because total T3 levels can be affected by changes in blood proteins, this test is not considered to be as accurate in diagnosing thyroid problems as the free T3 test, which measures only the unbound, active T3. As a result, measurement of free T3 has largely supplanted the total T3 test.

#### Low Results

A reduced blood level of total T3 is usually an indicator of hypothyroidism, although total T3 can also be reduced in the absence of hypothyroidism if the amount of thyroid binding proteins in the blood is low. Measuring free T4 and TSH levels usually clarify the diagnosis.

#### Optimal Results

A normal total T3 level is an indicator of normal thyroid hormone levels, but it must be interpreted in light of the TSH test and taking into consideration the amount of thyroid-binding protein in the blood.

#### High Results

An elevated blood level of total T3 usually indicates hyperthyroidism. However, total T3 levels can also be increased with conditions that increase the amount of thyroid binding proteins in the blood, such as pregnancy or taking oral contraceptives. Measuring free T3, free T4 and TSH levels usually clarify the diagnosis.



THYROID TESTS

12

### Free Thyroxin Index (FTI)

Optimal range: 4.8 – 12.7 IU/mL

In the recent past, the free thyroxin index (FTI) was a commonly-used method of estimating free T4 levels. The FTI is calculated by multiplying the total T4 level by the results of the T3 resin uptake test (T3RU). The T3RU, in turn, is a method of estimating the effect of thyroid binding proteins on the total amount of circulating thyroid hormones.

The FTI can be made inaccurate by several medical conditions that affect blood protein levels and is not used very much today. The free T4 test is much preferred.

**Low Results**

A low FTI often indicates hypothyroidism, but might also indicate the presence of numerous conditions affecting blood proteins, such as liver disease, kidney disease, diabetic ketoacidosis, or taking one of several drugs, including steroids or aspirin.

**Optimal Results**

A normal FTI usually indicates normal thyroid function, but must be interpreted in light of possible conditions affecting thyroid binding proteins.

**High Results**

An elevated FTI often indicates hyperthyroidism, but might also indicate the presence of numerous conditions affecting blood proteins, such as pregnancy, hepatitis, cirrhosis, malnutrition, or taking one of several drugs including oral contraceptives, fluorouracil, or clofibrate.

13

### T3 Resin Uptake (T3RU)

Optimal range: 25 – 50%

The T3RU test, as well as the FTI, are now largely obsolete and have been replaced in most labs by the free T4 test. Note that optimal ranges will vary from laboratory to laboratory.

The T3 resin uptake test (T3RU) is a way of estimating what proportion of a person's total T4 is bound to blood proteins. This test creates a fair amount of confusion, even among doctors, because while the lab test itself utilizes radiolabeled T3, the purpose of the test is to estimate the proportion of total T4 that is unbound. Specifically, the T3RU test is used to calculate the free thyroxin index (FTI).

**Low Results**

A T3RU result in the low range is suggestive of either hypothyroidism or an increase in thyroid-binding proteins in the blood. However, there is a fair amount of overlap in the T3RU result between hyperthyroid, normal, and hypothyroid ranges, rendering this test difficult to interpret. In clinical practice, the T3RU is used mainly to calculate the FTI and is not usually interpreted as a stand-alone value.

**Optimal Results**

A T3RU result in the normal range suggests normal thyroid function. However, there is a fair amount of overlap in the T3RU result between hyperthyroid, normal, and hypothyroid ranges, rendering this test difficult to interpret. In clinical practice, the T3RU is used mainly to calculate the FTI and is not usually interpreted as a stand-alone value.

**High Results**

A T3RU result in the high range is suggestive of either hyperthyroidism or a decrease in thyroid-binding proteins in the blood. However, there is a fair amount of overlap in the T3RU result between hyperthyroid, normal, and hypothyroid ranges, rendering this test difficult to interpret. In clinical practice, the T3RU is used mainly to calculate the FTI and is not usually interpreted as a stand-alone value.





THYROID TESTS

14

### Thyroid Binding Globulin (TBG)

**Optimal range when measured by electrophoresis: 10 – 24 mg/dL**

**Optimal range when measured by radioimmunoassay: 1.3 – 2 mg/dL**

Thyroid binding globulin (TBG) is the protein that binds most of the thyroid hormones that circulate in the blood. Because changes in the amount of TBG circulating in the blood will change the amount of total T3 and total T4 in the blood, on occasion it is useful to measure the amount of TBG to determine whether changes in thyroid hormone level are related to thyroid disease, or to changes in TBG levels. Measuring TBG has largely been supplanted by blood tests that measure free T3 and free T4.

#### Low Results

Low levels of TBG are associated with various illnesses, including liver disease, kidney disease, and various acute illnesses. In these cases, reduced total T4 and total T3 levels most often do not represent thyroid disease. Measuring TSH, free T4 and sometimes free T3 levels will clarify the thyroid status.

#### Optimal Results

Generally, a normal TBG measurement indicates that abnormal thyroid hormone levels are not related to protein binding. Measuring TSH, free T4, and sometimes free T3 levels will clarify the thyroid status.

#### High Results

Increased levels of TBG may increase total T4 and total T3 levels and are commonly associated with pregnancy and oral contraceptives. Measuring TSH, free T4, and sometimes free T3 levels will clarify the thyroid status.