Your Guide to Thyroid Function Tests

What is the thyroid gland and how does it work?

The thyroid gland lies in the front of your neck just below your Adam's apple. It is made up of two lobes, on either side of your windpipe, joined by a small bridge of thyroid tissue called the isthmus. The thyroid secretes two main hormones into the bloodstream. One of these is **thyroxine**, which contains four atoms of iodine and is often called T4. This in turn is converted to **tri-iodothyronine** (T3), which contains three atoms of iodine. It is the T3 that is biologically active and regulates your body's metabolism.

The amount of T4 and T3 secreted by your thyroid gland is regulated by the pituitary gland, which lies underneath your brain. The pituitary senses the level of thyroid hormones in your bloodstream, just as the thermostat in your living room senses the temperature. If the level drops just a little below normal the pituitary reacts by secreting a hormone called **thyroid-stimulating hormone** (TSH), which activates the thyroid gland to produce more T4. When the thyroid hormone levels rise above normal, the 'thermostat' senses this and the pituitary stops secreting TSH so that the thyroid makes less T4. TSH is also called **thyrotropin**.

What are thyroid function tests?

The usual blood tests done for thyroid function are TSH, T4 and sometimes T3.

In most cases, your TSH level will be the first hormone to be measured, because if this is normal, it is very likely that your thyroid is functioning normally. The exception to this is when a pituitary problem is suspected, in which case T4 should be measured as well.

It is good practice for doctors to measure the T4 in addition to the TSH in children, as T4 is essential to brain development.

Many laboratories use a 'cascade' system, so the other hormones will be measured if the TSH is not normal.

- If the TSH level is above the reference range, the blood T4 will be measured.
- If the TSH level is below the reference range, the blood T4 and T3 will be measured.

A blood sample is taken from a vein in the arm and sent off to the laboratory for analysis. Usually the 'free' or active portion of T4 and T3 is measured (i.e., FT4 and FT3). Laboratories use reference ranges to compare blood test results with results in the normal healthy population. Typical reference ranges for healthy adults are:

Test	From	To	Units
TSH	0.4	4.0	mU/l (milliunits per litre)
FT4	9.0	25.0	pmol/l (picomoles per litre)
FT3	3.5	7.8	pmol/l (picomoles per litre)

These ranges are only a guide and will vary according to laboratory. In pregnancy the serum TSH reference range is different from the general population and should ideally be based on reference ranges derived from healthy pregnant women in the same population. There are different reference ranges for testing babies and young children.

How can blood tests be used to diagnose thyroid disorders?

Your doctor will interpret these tests, together with your symptoms and how you feel, in order to diagnose whether you have a thyroid disorder, how severe it is, and how to treat it. If your TSH and FT4 results are outside the reference range your doctor may order additional tests. Current guidelines do not advise the use of thyroid hormone replacement if thyroid hormone levels are within normal limits.

TSH and FT4

If the TSH level is **high** and the FT4 result is **low** this suggests an underactive thyroid (hypothyroidism) that requires treatment.

If the TSH level is **low** and the FT4 result is **high** this suggests an overactive thyroid (hyperthyroidism) that requires treatment.

If the TSH level is slightly raised but the FT4 level is still within the normal reference range this is called subclinical hypothyroidism or mild thyroid failure. It may gradually develop into full-blown or clinical hypothyroidism over many years; an additional test for thyroid antibodies will help to determine the risk. Some people with subclinical hypothyroidism, particularly those whose TSH level is greater than 10mU/l or women who are trying to become pregnant, may benefit from treatment with levothyroxine.

A low TSH with a low FT4 may be a result of a failure of the pituitary gland (secondary hypothyroidism caused by hypopituitarism) or a response to any significant illness that doesn’t involve your thyroid.

FT3

This is usually only used in testing for hyperthyroidism or assessing its severity.

Thyroid antibodies

If the initial thyroid test results show signs of a thyroid problem and if there is a suspicion of an autoimmune thyroid disease, one or more thyroid antibody tests may be ordered. Antibody tests are used to confirm the diagnosis of autoimmune thyroid diseases. Some people will test positive for more than one type of thyroid antibody.

In people with subclinical thyroid disease the presence of antibodies can indicate that a person may go on to develop full-blown thyroid disease in the future, but that treatment is not yet required.

Positive antibodies can also be present in people without thyroid disease.

Antibodies	What do they indicate?
Thyroid peroxidase antibodies (TPOAb)	Raised in Hashimoto's thyroiditis (or autoimmune thyroiditis) and sometimes raised in Graves' disease
Thyroglobulin antibodies (Tg Ab)	Sometimes raised Hashimoto's thyroiditis
Thyroid stimulating hormone receptor antibodies (TSHR Ab, also known as TRAb)	Raised in Graves' disease

Is it necessary to repeat testing for thyroid antibodies?

It is rarely useful to repeat measurements of TPOAb and Tg Ab in adults and their level does not usually influence the treatment given. In children, antibodies may be tested when they move from paediatric to adult care in cases where the underlying cause of the thyroid dysfunction has not been established.

In contrast, measurements of TSHR Ab can be used to guide treatment decisions in Graves' disease (autoimmune thyroid overactivity). For example, relapse of Graves' disease is more likely if anti-thyroid medicines are stopped when TSHR Abs are still elevated.

Other more specialised tests are **thyroglobulin** (Tg) (used in monitoring people who have already been treated for differentiated thyroid cancer) and **calcitonin** (used in monitoring people with medullary thyroid cancer, or rarely as part of the diagnosis of thyroid disease where medullary cancer is suspected).

How can blood tests be used to manage thyroid disorders?

The aims of treatment are to make you feel better and to ensure that you come to no long-term harm from your thyroid hormone replacement. The blood test for TSH, which is the most sensitive marker of your thyroid status, is used as a biochemical marker to ensure that your thyroid hormone replacement is adequate.

It is recommended that patients on thyroid hormone replacement should keep their TSH within the reference range. Over-replacement (e.g. if the TSH becomes undetectable) may cause osteoporosis and long-term harm to the cardiovascular system. The target is different in thyroid cancer where the aim in selected patients is to keep the TSH level just below the reference range (usually to 0.1-0.5mU/L) for a period of time.

It is preferable to avoid having TSH levels that are either below or above the reference range during treatment for hypothyroidism. This is because population studies show that there is a slightly lower life expectancy and a small increased risk of health problems in the long-term for people who are both overtreated and

undertreated with levothyroxine. If you have thyroid blood tests that are outside the reference range over a long period of time, you should discuss these small risks with your doctor.

Within the limits described above, it is recommended that you and your doctor set individual targets that are right for your particular circumstances.

If you have been diagnosed with hypothyroidism you will start treatment with levothyroxine - a synthetic version of the thyroxine (T4) produced by the thyroid gland.

If you have hyperthyroidism the available treatments are antithyroid drugs to reduce the production of thyroid hormones; surgery to remove all or part of the thyroid gland; or radioactive iodine to reduce the activity of the thyroid. Your doctor will discuss treatment options with you.

At the start of treatment your doctor will carry out blood tests usually every few weeks. The results will help to fine-tune your treatment. You will normally have less frequent tests when you are stable on your treatment. In **hypothyroidism**, a TSH test once a year will check that levels are within the reference range.
In **hyperthyroidism** the usual tests are TSH and FT4; how often these take place will depend on the treatment.

You will have additional tests if the results are abnormal, and you should tell your doctor about any change in your health between blood tests. If your results are normal, but you still don't feel entirely well, ask your doctor whether there is room for a slight adjustment of your dose. This can be considered if your TSH level can be kept within the reference range. You should not, however, alter your dose without discussing this with your doctor.

Once you start on levothyroxine it may take several months before your symptoms improve even if the tests results are satisfactory. This is especially the case in patients with a history of Graves' disease who may have been hyperthyroid for many months and who may take a considerable time to adjust to feeling 'normal' with satisfactory test results following radioiodine or surgery.

What can affect the results of thyroid function tests?

Thyroid function tests can be influenced by medications and illnesses. Let the person taking your blood test know of anything that might affect the readings, especially:

- Any serious illness such as heart attack, infection, trauma, serious liver disease or kidney failure
- Medication used to treat thyroid disorders, especially when taking too much or too little
- Any other medication you are taking, including: the contraceptive pill, steroid hormones, anticonvulsants, anti-inflammatory drugs, lithium (used for certain mental disorders) and amiodarone (used to control irregularities of the heart beat) and any mineral or vitamin supplements particularly if the preparation contains iodine or biotin.

When should I have a thyroid function blood test?

You should make an appointment with your GP and ask for a blood test if you have:

- Symptoms of an over- or underactive thyroid
- Swelling or thickening in the neck
- An irregular or fast heart rate
- High cholesterol (which causes atherosclerosis – a build-up of fat in the arteries)
- Osteoporosis (fragile or thinning bones)
- Fertility problems, abnormal menstrual cycles, recurrent miscarriage, low libido
- Family history of autoimmune disorders, e.g., type 1 diabetes, vitiligo, etc.

Or if you are:

- Feeling unwell after having a baby
- Planning pregnancy or in early pregnancy (and you have a family history or personal history of thyroid disorders, a past history of postpartum thyroiditis, or type 1 diabetes)

You should have a blood test once a year, or more frequently if your doctor advises, if:

- You have a diagnosed thyroid disorder
- You have had previous treatment for an overactive thyroid (radioactive iodine, thyroid surgery, medication)
- You have had irradiation to the head and neck after surgery for head and neck cancer
- Before you have treatment with amiodarone, lithium or alemtuzumab (for multiple sclerosis) then 6-12 months during treatment and 12 months after treatment

People with Down's syndrome, Turner syndrome, Addison's disease or other autoimmune diseases should also be tested regularly.

Some important points….

- Blood tests are currently the most accurate way to diagnose and manage thyroid disorders
- Your symptoms and how you feel are an important part of the diagnosis
- It is important for your health that the TSH level is within the reference range
- It is rarely necessary to repeat antibody tests in Hashimoto's disease
- If you are taking medication for a thyroid disorder, there may be scope to fine-tune your treatment so that you feel better
- If you have a diagnosed thyroid disorder or have had previous treatment for an overactive thyroid, it is important to have a blood test every 12 months, or as advised by your doctor
- If you have a thyroid disorder you should have a blood test in early pregnancy or if you are planning a pregnancy
- If you are taking medication, do not alter your dose without discussing this with your doctor

Thyroid problems often run in families and if family members are unwell they should be encouraged to discuss with their own GP whether thyroid testing is warranted.

If you have questions or concerns about your thyroid disorder, you should talk to your doctor or specialist as they will be best placed to advise you.

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