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**SUBJECT: CHEMCIAL PATHOLOGY DATED:22/6/2020**

**QUESTION NO 1** : Write a detail note on Thyroid hormones.

**ANSWER:** Thyroid is an endocrine gland situated at the root of the neck on either side of the trachea. The thyroid gland is essential to the [endocrine system](https://www.hormone.org/what-is-endocrinology/the-endocrine-system). It is located in front of the neck and is responsible for the production of thyroid hormones. The thyroid gland releases triiodothyronine (T3) and [thyroxine](https://www.hormone.org/your-health-and-hormones/glands-and-hormones-a-to-z/hormones/thyroxine)(T4). These hormones play an important role in regulation of your weight, energy levels, internal temperature, skin, hair, nail growth, and more.

**What is T4?**

Thyroxine (T4) is produced by the thyroid gland under regulation from the hypothalamus and pituitary gland. The feedback loop signals to the hypothalamus in to release thyrotropin-releasing hormone, which then stimulates the pituitary gland to release the thyroid stimulating hormone.

**What is T3?**

T3 is a second thyroid hormone that is produced by the thyroid gland, but also in other tissues through deiodination (enzymatic conversion) of T4. T3 helps maintain muscle control, brain function and development, heart and digestive functions. It also plays a role in the body’s metabolic rate and the maintenance of bone health.

**HYPERTHYRIODISM:**

Having too much T3 in the bloodstream is referred to as thyrotoxicosis. This condition often results from overactivity in the thyroid gland, or hyperthyroidism. Hyperthyroidism occurs in conditions such as Graves’ disease, inflammation of the thyroid or a benign tumor. Signs of thyrotoxicosis include weight loss, increased appetite, palpitations, irregular menstrual cycle, tiredness, irritability, and hair thinning. Hyperthyroidism can also occur when supplements with T3 are ingested.

**HYPHOTHYRIODISM**

Hypothyroidism is a condition that occurs if the thyroid gland does not produce enough of the thyroid hormone. This may be due to autoimmune conditions, such as Hashimoto’s thyroiditis or certain medications. Hypothyroidism can also occur in pituitary dysfunction, such as pituitary tumors or inflammation. Hypothyroidism tends to run in families and more common in adults, as well as women. Symptoms may include tiredness, mental depression, feeling cold, weight gain, dry skin, constipation, and menstrual irregularities.

**Rate of secretion**

* Thyroxine = 80 to 90 μg/day
* Tri-iodothyronine = 4 to 5 μg/day

Plasma Level

* Total T3 = 0.12 ìg/dL
* Total T4 = 8 ìg/dL.

**FUNCTION**

* To increase basal metabolic rate
* To stimulate growth.
  + Action on fat metabolism
  + Action on carbohydrate metabolism
  + Action on protein metabolism
  + Action on body weight
  + Action on cardiovascular system.

**DISEASE CONDITIONS:**

[**Graves Disease**](https://www.hormone.org/diseases-and-conditions/graves-disease)

Graves disease is an autoimmune disease more common in women between age 20 and 50, who often have a family history of thyroid disease. Learn more about Graves' disease, including the effects it has on women's hormone health and pregnancy.

**Sign and symptoms**

Toxic goiter, Polycythemia, Tachycardia, atrial fibrillation, Increased sweating, Decreased body weight, Diarrhea, Muscular weakness etc.

### [Goiter](https://www.hormone.org/diseases-and-conditions/goiter)

When your thyroid gland is enlarged, it can produce too much, too little, or just enough thyroid hormone. Learn more about goiter, including its diagnosis impact on other thyroid conditions and treatment options.

**Sign and symptoms**

* Anemia, Fatigue , Extreme somnolence with sleeping disturbance, decreased cardiovascular functions such as reduction in rate and force of contraction of the heart, cardiac output and blood volume , Increase in body weight, Constipation, Depressed hair growth, Scaliness of skin, Cold intolerance.

### [Hashimoto Disease](https://www.hormone.org/diseases-and-conditions/hashimoto-disease)

Hashimoto disease is an autoimmune condition affecting the thyroid gland. Learn more about Hashimoto disease, including the symptoms, complications and treatments associated with this autoimmune condition.

**THYROID FUNCTION TESTS**

* Measurement of plasma level of T3 and T4.
* Measurement of TRH and TSH.
* Measurement of basal metabolic rate.

**Measurement of plasma level of T3 and T4:**

For hyperthyroidism or hypothyroidism, the most accurate diagnostic test is the direct measurement of concentration of “free” thyroid hormones in the plasma, i.e. T3 and T4.

**Measurement of TRH and TSH**

There is almost total absence of these two hormones in hyperthyroidism but increase in hypothyroidism. It is because of negative feedback mechanism, by the increased level of thyroid hormones.

**QUESTION NO 2:** Explain and classify Adrenocorical Hormone.

**ANSWER:**

There are 2 adrenal glands.

* 4 grams each.
* At the superior pole of the 2 kidneys.
* Each gland is composed of 2 distinct parts:

1. Adrenal Cortex

2. Adrenal Medulla

**Adrenal cortex**

The adrenal cortex composes the outer layer of the adrenal gland and consists of three sublayers called zonae each of which produces structurally similar and functionally different compounds and hormones. The cortical zonae are the zona glomerulosa, fasciculata and reticularis producing and secreting minerocorticoids, glucocorticoids and sex steroids respectively.

* **Zona Glomerulosa:** is the outermost layer of the cortex specialized in the production and secretion of minerocorticoids and predominantly aldosterone a hormone involved in extracellular fluid volume and osmolality control. Aldosterone is generally responsible for the renal absorption of Na+ and exceretion of K+ from the distal part of the distal convoluted tubule and collecting duct and intestinal absorption of Na+ in lesser extend.
* **Zona Fasciculata:** is the intermediate layer of the cortex specialized in the production and secretion of glucocorticoids and predominantly cortisol and corticosterone hormones involved in metabolism control along with inflammatory regulation being of vital importance for life maintenance.
* **Zona Reticularis:** is the innermost layer of the cortex specialized in the production and secretion of sex steroid hormones and predominantly androgens and androgen precursors. The zona reticularis secretes androstenedione, dehydroepiandrosterone and dehydroepiandrostenedione which are not effective androgens as testosterone. However, when secreted they are transported to the gonads either testes or ovaries where they are converted to the more potent testosterone and to the most potent sex steroid hormone called dihydrotestosterone. The androgens stimulate and control the development and maintenance of male characteristics (and of female characteristics to lesser extend). This includes the activity of the accessory male sex organs and development of male secondary sex characteristics.

### Adrenal medulla

The adrenal medulla is the innermost part of the adrenal gland situated underneath the adrenal cortex and resembles literally a large ganglion since it is composed of medullary chromaffin cells which are considered to have neuroendocrine properties since they derive from neuronal embryonic origin during the adrenal gland development. The adrenal medulla is an area specialized in production and secretion of norepinephrine and epinephrine collectively known as catecholamines. Catecholamines perform more or less the same function as the neurotransmitters of the adrenergic fibers of the sympathetic nervous system, acting through the same type of adrenergic receptors.

The adrenocortical hormones are the compounds secreted by the adrenal gland except catecholamines. Therefore the adrenocortical hormones refer to glucocorticoids-cortisol, minerocorticoids-aldosterone and sex steroids-andogens. Precursor of all adrenocortical hormones is cholesterol.

### Regulation of the adrenocortical hormones secretion

1. The secretion of adrenocortical hormones and specifically that of glucocorticoids and sex steroids is controlled by the hypothalamus whereas regulation of aldosterone release is under the control of the extracellular fluid volume regulation and Na+ balance.
2. The paraventricular nuclei of the hypothalamus produce and secrete CRH (corticotropin releasing hormone)
3. CRH enters the primary hypophyseal capillary bed at the median eminence and enters the secondary hypophyseal capillary bed
4. CRH reaches the anterior pituitary lobe and acts on specialized cells called corticotrophs.
5. Stimulation of the corticotrophs induces production and secretion of ACTH (adrenocorticotropic hormone)
6. ACTH enters the secondary hypophyseal capillary bed and reaches the blood circulation
7. ACTH acts in an endocrine fashion reaching the adrenal cortex affecting the secretory status of the adrenocortical cells

### Glucocorticoids:

##### **Characteristiscs:**

Glucocorticoids are the hormones secreted by the zona fasciculata of the adrenal cortex. The most abundant glucocorticoid is cortisol. Cortisol is an essential hormone for the human body, for example, bilateral removal of the adrenal glands eventually causes death, thus the patient must be administered cortisol for the rest of the life in order to sustain life. Cortisol is not stored in the adrenocortical cell to any significant extent, so a need for high amount of hormone requires rapid activation of the entire synthetic mechanism from cholesterol. Cortisol is transported in blood bound to a carrier protein called transcortin. Cortisol secretion exhibits distinct diurnal variation with a peak in the morning and minimum during sleep.

##### **Function:**

**1.Metabolic activity**

Cortisol promotes mobilization of protein in order to provide amino acids for gluconeogenesis critical for the survival of a fasting body. This is achieved primarily through acceleration of protein degradation and inhibiting of protein synthesis. During hypoglycemia the initial response to increase the glycemia is promoted by glucagon, thyroxin and epinephrine and later by cortisol.

Cortisol has a weak lipolytic effect promoting mobilization of fatty acids and glycerol during fasting conditions in order to enhance the formation of energy through β oxidation and gluconeogenesis from fats.

**2.Antiinflammatory activity**

inhibition of the recruitment of circulating leukocytes to the site of trauma or infection

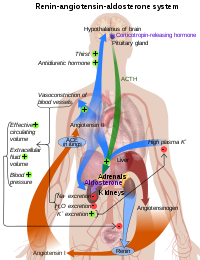
inhibition of differentiation and proliferation of local inflammatory basophils and mast cells

decrease of the number of T cells with subsequent inhibition of the cell-mediated immunity

decrease of phagocytic and bacteriocidal activity of neutrophils and probably macrophages

reduction of local release of proteolytic enzymes

### Minerocorticoids:

[](https://www.wikilectures.eu/w/File:Renin-angiotensin_system_in_man_shadow.svg)

RAAS - Renin Angiotensin Aldosterone System

Aldosterone circulates in plasma bound to an aldosterone-binding protein, to transcortin and to albumin. Aldosterone receptor in the cytoplasm of target cells influence the transcription and protein synthesis in order to provide Na+ and K+ pumps for NaCl reabsorption and potassium excretion .

In the renal nephorns, aldosterone stimulates the active reabsorption of Na+ from the tubular fluid by the distal part of the distal tubules and collecting ducts and excretion of potassium. This is achieved through stimulation of the Na+/K+ ATPase pump and increase of density of Na+ channels at the luminal membrane

1. Stimulation of Na+ reabsorption from the intestine
2. Decrease in the ratio of Na+ over K+ in sweat and saliva
3. Indirect increase of blood volume and blood pressure

### Sex steroids

Dehydroepiandrosterone and androstenedione are the major androgenic product of the adrenal glands possessing only weak androgenic effect, but they are converted into testosterone in peripheral tissues and especially in gonads. In women the adrenals supply half of the androgenic hormone requirements. The further conversion to estradiol and estrone is of little significance in women until the ovaries cease to function after menopause. Then estrogens secreted directly from adrenal glands or arising in the periphery from adrenal precursors become the only source for this biological activity. In man, adrenal androgen precursors have little biological importance because the testes produce a large quantity of testosterone.

**QUESTION NO 3:**  Define and explain Hyperthyroidism and Hypothyroidism.

**ANSWER: HYPERTHYRIODISM:**

Having too much T3 in the bloodstream is referred to as thyrotoxicosis. This condition often results from overactivity in the thyroid gland, or hyperthyroidism. Hyperthyroidism occurs in conditions such as Graves’ disease, inflammation of the thyroid or a benign tumor. Signs of thyrotoxicosis include weight loss, increased appetite, palpitations, irregular menstrual cycle, tiredness, irritability, and hair thinning. Hyperthyroidism can also occur when supplements with T3 are ingested.

Common [symptoms of hyperthyroidism](https://www.medicinenet.com/hyperthyroidism_symptoms_and_signs/symptoms.htm) include

* restlessness,
* agitation,
* [anxiety](https://www.medicinenet.com/anxiety/article.htm),
* [tremors](https://www.medicinenet.com/tremor/article.htm),
* [weight loss](https://www.medicinenet.com/weight_loss/article.htm) despite an [increased appetite](https://www.medicinenet.com/increased_appetite/symptoms.htm),
* [sweating](https://www.medicinenet.com/hyperhidrosis_sweating_pictures_slideshow/article.htm),
* rapid [heart](https://www.medicinenet.com/heart_how_the_heart_works/article.htm) rate,
* intolerance to heat, and
* frequent bowel movements.

[Graves' disease](https://www.medicinenet.com/graves_disease/article.htm) is the most common cause of hyperthyroidism, and can be associated with eye disease (Graves' opthalmopathy).

* Many other health problems can cause an overactive thyroid, for example, [thyroiditis](https://www.medicinenet.com/thyroiditis/article.htm) or taking too many thyroid hormones.
* Treatments for hyperthyroidism include antithyroid medications, radioactive ablation, and surgery.
* There is no conclusive evidence that a special [diet](https://www.medicinenet.com/diet_plans_and_programs/article.htm) will help [hypothyroidism symptoms](https://www.medicinenet.com/hypothyroidism_symptoms_and_signs/symptoms.htm); however, your doctor may recommend a [diet](https://www.medicinenet.com/diet_and_nutrition_quiz/quiz.htm) low in [iodine](https://www.medicinenet.com/iodine_strong-oral/article.htm) if you are going to have radioactive iodine treatment.

#### Graves' disease symptoms and signs

Signs and symptoms of Graves’ disease include those of hyperthyroidism; however, Graves’ disease may be associated with eye disease (Graves' opthalmopathy) and skin lesions (dermopathy). Opthalmopathy can occur before, after, or at the same time as the hyperthyroidism. Early on, it may cause [sensitivity to light](https://www.medicinenet.com/photophobia/symptoms.htm) and a feeling of "sand in the eyes." The eyes may be reddened and produce excess tears. Swelling behind the eyeballs causes the eyes to protrude, and [double vision](https://www.medicinenet.com/double_vision/article.htm) can occur. The degree of opthalmopathy is worsened in those who smoke.

In addition to the symptoms of hyperthyroidism mentioned above, Graves' disease may be associated with eye disease (Graves' opthalmopathy) and skin lesions (dermopathy). Opthalmopathy can occur before, after, or at the same time as the hyperthyroidism. Early on, it may cause sensitivity to light and a feeling of "sand in the eyes." The eyes may be reddened and produce excess tears. Swelling behind the eyeballs causes the eyes to protrude, and [double vision](https://www.medicinenet.com/double_vision/symptoms.htm) can occur. The degree of opthalmopathy is worsened in those who smoke.

The course of the eye disease is often independent of the [thyroid disease](https://www.medicinenet.com/thyroid_disorders/article.htm), and steroid

### Other causes of hyperthyroidism

#### Functioning adenoma and toxic multinodular goiter

As we age, lumps or nodules may form in the thyroid gland. Usually, these lumps do not produce thyroid hormones and require no treatment. Occasionally, a nodule may become "autonomous," which means that it does not respond to pituitary regulation and produces thyroid hormones independently. This becomes more likely if the nodule is larger than 3 cm. When there is a single nodule that is independently producing thyroid hormones, it is called a

functioning nodule. If there is more than one functioning nodule, the term toxic, multinodular goiter is used. Functioning nodules may be readily detected with a thyroid scan.

#### Excessive intake of thyroid hormones

Taking too much thyroid hormone medication is actually quite common. Excessive doses of thyroid hormones frequently go undetected due to the lack of follow-up of patients taking their thyroid medicine. Other persons may be abusing the drug in an attempt to achieve other goals such as [weight loss](https://www.medicinenet.com/weight_loss/symptoms.htm).

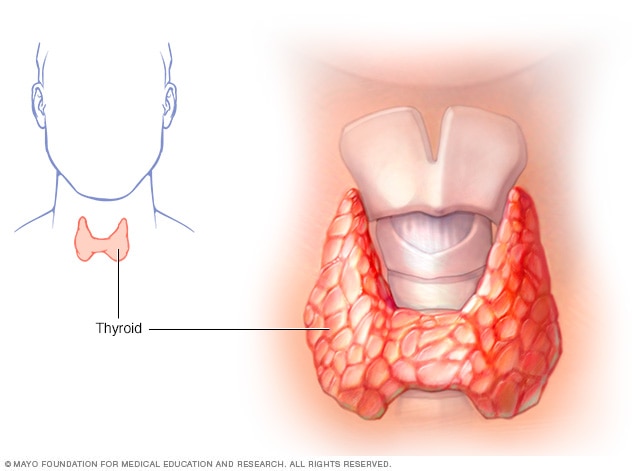
#### Abnormal secretion of TSH

A [tumor](https://www.medicinenet.com/tumor_grade/article.htm) in the pituitary gland may produce an abnormally high secretion of TSH (the thyroid stimulating hormone produced by the pituitary gland). This leads to excessive signaling to the thyroid gland to produce thyroid hormones. This condition is very rare and can be associated with other abnormalities of the pituitary gland. To identify this disorder, an endocrinologist performs elaborate tests to assess the release of TSH.

**HYPHOTHYRIODISM**

Hypothyroidism is a condition that occurs if the thyroid gland does not produce enough of the thyroid hormone. This may be due to autoimmune conditions, such as Hashimoto’s thyroiditis or certain medications. Hypothyroidism can also occur in pituitary dysfunction, such as pituitary tumors or inflammation. Hypothyroidism tends to run in families and more common in adults, as well as women. Symptoms may include tiredness, mental depression, feeling cold, weight gain, dry skin, constipation, and menstrual irregularities.

**Symptoms**



The signs and symptoms of hypothyroidism vary, depending on the severity of the hormone deficiency. Problems tend to develop slowly, often over a number of years.

At first, you may barely notice the symptoms of hypothyroidism, such as fatigue and weight gain. Or you may simply attribute them to getting older. But as your metabolism continues to slow, you may develop more-obvious problems.

Hypothyroidism signs and symptoms may include:

* Fatigue
* Increased sensitivity to cold
* Constipation
* Dry skin
* Weight gain
* Puffy face
* Hoarseness
* Muscle weakness
* Elevated blood cholesterol level
* Muscle aches, tenderness and stiffness
* Pain, stiffness or swelling in your joints
* Heavier than normal or irregular menstrual periods
* Thinning hair
* Slowed heart rate
* Depression
* Impaired memory
* Enlarged thyroid gland (goiter)

### Hypothyroidism in infants

Although hypothyroidism most often affects middle-aged and older women, anyone can develop the condition, including infants. Initially, babies born without a thyroid gland or with a gland that doesn't work properly may have few signs and symptoms. When newborns do have problems with hypothyroidism, the problems may include:

* Yellowing of the skin and whites of the eyes (jaundice). In most cases, this occurs when a baby's liver can't metabolize a substance called bilirubin, which normally forms when the body recycles old or damaged red blood cells.
* A large, protruding tongue.
* Difficulty breathing.
* Hoarse crying.
* An umbilical hernia.

As the disease progresses, infants are likely to have trouble feeding and may fail to grow and develop normally. They may also have:

* Constipation
* Poor muscle tone
* Excessive sleepiness

When hypothyroidism in infants isn't treated, even mild cases can lead to severe physical and mental retardation.

### Hypothyroidism in children and teens

In general, children and teens who develop hypothyroidism have the same signs and symptoms as adults do, but they may also experience:

* Poor growth, resulting in short stature
* Delayed development of permanent teeth
* Delayed puberty
* Poor mental development

**QUESTION NO 4:** How calcium is regulated? Define Osteomalaica.

**ANSWER:**

The body maintains very tight control over the calcium circulating in the blood at any given time. The equilibrium is maintained by an elegant interplay of calcium absorbed from the intestines, movement of calcium into and out of the bones, and the kidney’s reclamation and excretion of calcium into the urine.

If the serum calcium level falls, the parathyroid glands release PTH into the blood and this signals cells in bone (osteoclasts) to release calcium from the bone surfaces. PTH also signals the kidney to reclaim more calcium before it is excreted in the urine and also stimulates synthesis of the active form of vitamin D.

There are at least three hormones intimately involved in the regulation of the level of calcium in the blood: parathyroid hormone (PTH), calcitonin and calcitriol (1, 25 dihydroxyvitamin D, the active form of vitamin D). PTH comes from the parathyroid glands located behind the thyroid gland in the lower part of the neck and calcitonin comes from cells in the thyroid gland, both of which monitor and maintain calcium levels in the blood. The active form of vitamin D is synthesized in the kidney under the control of PTH.

Special cells that reside in the thyroid gland along with thyroid hormone containing cells release another hormone, calcitonin, into the blood. Calcitonin signals osteoclasts to slow down removal of calcium from bone; this action tends to lower levels of blood calcium. Conversely, shutting off calcitonin allows osteoclasts to get back in business to release needed calcium from bone.

The PTH system provides long-term, day-to-day regulation of calcium levels by many hormones working in concert. This hormonal “feedback loop” is governed by the parathyroid glands and the calcitonin-secreting cells of the thyroid gland by their constant monitoring of the blood calcium levels. The body also has a minute to minute regulation of calcium levels from osteocytes in bone—these cells can instantly release needed calcium or instantly stop releasing calcium depending on immediate needs (too little or too much calcium coming into the bloodstream).

Calcium is one of the body's [electrolytes](https://www.msdmanuals.com/home/hormonal-and-metabolic-disorders/electrolyte-balance/overview-of-electrolytes), which are [minerals](https://www.msdmanuals.com/home/disorders-of-nutrition/minerals/overview-of-minerals) that carry an electric charge when dissolved in body fluids such as blood, but most of the body's calcium is uncharged. (See also [Overview of Electrolytes](https://www.msdmanuals.com/home/hormonal-and-metabolic-disorders/electrolyte-balance/overview-of-electrolytes).)

About 99% of the body’s calcium is stored in the bones, but cells (particularly muscle cells) and blood also contain calcium. Calcium is essential for the following:

* Formation of bone and teeth
* Muscle contraction
* Normal functioning of many enzymes
* Blood clotting
* Normal heart rhythm

The body precisely controls the amount of calcium in cells and blood. The body moves calcium out of bones into blood as needed to maintain a steady level of calcium in the blood. If people do not consume enough calcium, too much calcium is mobilized from the bones, weakening them. [Osteoporosis](https://www.msdmanuals.com/home/bone,-joint,-and-muscle-disorders/osteoporosis/osteoporosis) can result. To maintain a normal level of calcium in blood without weakening the bones, people need to consume at least 1,000 to 1,500 milligrams of calcium a day.

The level of calcium in blood is regulated primarily by two hormones:

* Parathyroid hormone
* Calcitonin

**Parathyroid hormone** is produced by the four parathyroid glands, located around the [thyroid gland](https://www.msdmanuals.com/home/hormonal-and-metabolic-disorders/thyroid-gland-disorders/overview-of-the-thyroid-gland) in the neck. When the calcium level in blood decreases, the parathyroid glands produce more parathyroid hormone. When the calcium level in blood increases, the parathyroid glands produce less hormone. Parathyroid hormone does the following:

* Stimulates bones to release calcium into blood
* Causes the kidneys to excrete less calcium in urine
* Stimulates the digestive tract to absorb more calcium
* Causes the kidneys to activate vitamin D, which enables the digestive tract to absorb more calcium

**Calcitonin** is produced by cells of the thyroid gland. It lowers the calcium level in blood by slowing the breakdown of bone, but only slightly.

Too little calcium in the blood is called [hypocalcemia](https://www.msdmanuals.com/home/hormonal-and-metabolic-disorders/electrolyte-balance/hypocalcemia-low-level-of-calcium-in-the-blood). Too much calcium in the blood is called [hypercalcemia](https://www.msdmanuals.com/home/hormonal-and-metabolic-disorders/electrolyte-balance/hypercalcemia-high-level-of-calcium-in-the-blood)

#### Body Distribution of Calcium and Phosphate

There are three major pools of calcium in the body:

* Intracellular calcium: A large majority of calcium within cells is sequestered in mitochondria and endoplasmic reticulum. Intracellular free calcium concentrations fluctuate greatly, from roughly 100 nM to greater than 1 uM, due to release from cellular stores or influx from extracellular fluid. These fluctuations are integral to calcium's role in intracellular signaling, enzyme activation and muscle contractions.
* Calcium in blood and extracellular fluid: Roughly half of the calcium in blood is bound to proteins. The concentration of ionized calcium in this compartment is normally almost invariant at approximately 1 mM, or 10,000 times the basal concentration of free calcium within cells. Also, the concentration of phosphorus in blood is essentially identical to that of calcium.
* Bone calcium: A vast majority of body calcium is in bone. Within bone, 99% of the calcium is tied up in the mineral phase, but the remaining 1% is in a pool that can rapidly exchange with extracellular calcium.

As with calcium, the majority of body phosphate (approximately 85%) is present in the mineral phase of bone. The remainder of body phosphate is present in a variety of inorganic and organic compounds distributed within both intracellular and extracellular compartments. Normal blood concentrations of phosphate are very similar to calcium.

#### Fluxes of Calcium and Phosphate

Maintaining constant concentrations of calcium in blood requires frequent adjustments, which can be described as fluxes of calcium between blood and other body compartments. Three organs participate in supplying calcium to blood and removing it from blood when necessary:

|  |  |
| --- | --- |
| * The small intestine is the site where dietary calcium is absorbed. Importantly, efficient absorption of calcium in the small intestine is dependent on expression of a calcium-binding protein in epithelial cells. * Bone serves as a vast reservoir of calcium. Stimulating net resorption of bone mineral releases calcium and phosphate into blood, and suppressing this effect allows calcium to be deposited in bone. * The kidney is critcally important in calcium homeostasis. Under normal blood calcium concentrations, almost all of the calcium that enters glomerular filtrate is reabsorbed from the tubular system back into blood, which preserves blood calcium levels. If tubular reabsorption of calcium decreases, calcium is lost by excretion into urine. | http://www.vivo.colostate.edu/hbooks/pathphys/endocrine/thyroid/caflux.gif |

#### Hormonal Control Systems

Maintaining normal blood calcium and phosphorus concentrations is managed through the concerted action of three hormones that control fluxes of calcium in and out of blood and extracellular fluid:

[Parathyroid hormone](http://www.vivo.colostate.edu/hbooks/pathphys/endocrine/thyroid/pth.html) serves to increase blood concentrations of calcium. Mechanistically, parathyroid hormone preserves blood calcium by several major effects:

* Stimulates production of the biologically-active form of vitamin D within the kidney.
* Facilitates mobilization of calcium and phosphate from bone. To prevent detrimental increases in phosphate, parathyroid hormone also has a potent effect on the kidney to eliminate phosphate (phosphaturic effect).
* Maximizes tubular reabsorption of calcium within the kidney. This activity results in minimal losses of calcium in urine.

**QUESTION NO 5:** Write a note on Sex hormone.

**ANSWER:**

Hormones are chemical messengers produced by the endocrine glands and are secreted directly into the blood. These help in regulating different bodily functions such as sleep, appetite, growth, etc. For instance, the growth hormones regulate the growth and development of the body, while the sex hormones are crucial for sexual development,

Here. let us explore in detail what are sex hormones and their role in reproduction.

## Sex Hormones

The sex hormones play a key role in [reproduction](https://byjus.com/biology/reproduction/) and sexual development. These are mainly produced by the gonads and adrenal glands. The sex hormones are generally involved in:

* Reproduction and sexual development
* Puberty
* Inflammatory responses
* Promoting hair growth
* Regulating cholesterol levels
* Body fat distribution

The levels of sex hormones keep fluctuating the entire life. These fluctuations can lead to health issues such as hair loss, bone loss, infertility, etc.

There are several factors that affect the levels of these hormones. These include:

* Age
* Menstruation
* Menopause
* Menstruation
* Stress
* Medications

## Female Sex Hormones

In females, the sex hormones are released by the ovaries and adrenal glands. The main sex hormones in females include – progesterone, estrogen, and small amounts of testosterone.

### Progesterone

The hormone progesterone is produced by the adrenal glands, ovaries and placenta. The progesterone levels are higher during ovulation and it fastens during pregnancy. Progesterone also stabilizes the menstrual cycle and prepares the body for pregnancy.

Low level of progesterone leads to an imbalance in the menstrual cycle and complications during pregnancy.

### Estrogen

Estrogen is widely released by the ovaries. Only a small amount of estrogen is released by the adrenal glands and fat cells. It is responsible for sexual and reproductive development during puberty.

### Testosterone

A very small amount of testosterone is produced in females. It affects menstruation, fertility, RBC production, and bone and tissue mass.

Estrogen is the major female hormone. The lion’s share comes from the [ovaries](https://www.healthline.com/human-body-maps/ovary), but small amounts are produced in the adrenal glands and fat cells. During pregnancy, the placenta also makes estrogen.

Estrogen plays a big role in reproductive and sexual development, including:

* [puberty](https://www.healthline.com/health/parenting/stages-of-puberty)
* [menstruation](https://www.healthline.com/health/how-long-does-your-period-last)
* [pregnancy](https://www.healthline.com/health/pregnancy)
* [menopause](https://www.healthline.com/health/menopause)

Estrogen also affects the:

* brain
* cardiovascular system
* hair
* musculoskeletal system
* skin
* urinary tract

Estrogen levels can be determined by a [blood test](https://www.healthline.com/health/estradiol-test). While it can vary from person to person, these are what’s considered the [normal ranges](https://www.mayomedicallaboratories.com/test-catalog/Clinical+and+Interpretive/81816) in picograms per milliliter (pg/mL):

* **Adult female, premenopausal:** 15-350 pg/mL
* **Adult female, postmenopausal:** <10 pg/mL
* **Adult male:** 10-40 pg/mL

Levels will vary greatly throughout the menstrual cycle.

### Progesterone

The ovaries produce the female sex hormone progesterone after [ovulation](https://www.healthline.com/health/pregnancy/how-long-does-ovulation-last). During pregnancy, the placenta also produces some.

The role of progesterone is to:

* prepare the lining of the uterus for a fertilized egg
* support pregnancy
* suppress estrogen production after ovulation

Progesterone levels can be determined by [a blood test](https://www.healthline.com/health/serum-progesterone). [Normal ranges](https://www.urmc.rochester.edu/encyclopedia/content.aspx?ContentTypeID=167&ContentID=progesterone) are in nanograms per milliliter (ng/mL):

|  |  |
| --- | --- |
| Phase | Range |
| before puberty | 0.1–0.3 ng/mL |
| during first (follicular) stage of menstrual cycle | 0.1–0.7 ng/mL |
| while ovulating (luteal stage of cycle) | 2–25 ng/mL |
| first trimester of pregnancy | 10–44 ng/mL |
| second trimester | 19.5–82.5 ng/mL |
| third trimester | 65–290 ng/mL |

### Testosterone

Small amounts of [testosterone](https://www.healthline.com/health/facts-about-testosterone) come from the adrenal glands and ovaries. This hormone plays a role in several body functions, including:

* sexual desire
* regulation of the menstrual cycle
* bone and [muscle strength](https://www.healthline.com/health/healthy-sex/masturbating-before-workout)

[A blood test](https://www.healthline.com/health/testosterone-test) can determine your testosterone level. The [normal range](https://www.urmc.rochester.edu/encyclopedia/content.aspx?ContentTypeID=167&ContentID=testosterone_total) for females is 15 to 70 nanograms per deciliter (ng/dL).

## Male Sex Hormones

Testosterone is the only male sex hormone responsible for sexual and reproductive development. It belongs to a class of male hormones called androgens that are also known as steroids. It is mainly produced in the testes with a very small amount produced in the adrenal glands.

The testosterone production is controlled by the hypothalamus and pituitary gland. It is responsible for the development of male sex organs during birth and development of secondary sexual characteristics during puberty.

The testosterone levels gradually decrease with age. It results in impotence, low sperm count, shrunken testes, depression, irritability, etc.

## Functions of Sex Hormones

Following are the important functions of sex hormones:

### Sex Hormones at Puberty

Puberty leads to many changes in the body both in boys and girls. Development of secondary sexual characteristics is one of the major changes that occur during adolescence.

Endocrine system or [endocrine glands](https://byjus.com/biology/endocrine-glands/) are a group of glands that secrete some chemicals into the blood. These chemicals released by endocrine glands are called hormones. These hormones are responsible for the changes during puberty.

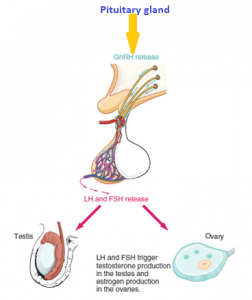
During adolescence male testis and female ovaries mature. The matured gonads (sex organs) begin to secrete hormones. These hormones are called sex hormones. They are responsible for the changes during puberty and the development of secondary sexual characteristics in males and females.

In males, the appearance of facial hair, and hair growth on the chest and pubic region begins. While in females, the development of mammary glands and onset of menstruation occurs during puberty. The overall secretion of sex hormones is controlled by the called pituitary gland.

### Sex Hormones in Initiating Reproductive Function

Endocrine glands release hormones directly into the blood. The level of a particular hormone may cause a huge difference in the actions and functions of our body. Hence, hormones are secreted as per the requirements of our body.

Hormones work through a feedback mechanism. The organ to which the hormone is targeted is called the target organ (target site). The target site and the hormones correspond to each other; hormones are highly specific in their action. The hormones act on their target site and lead to reproductive changes in us.



Sex Hormones at Puberty