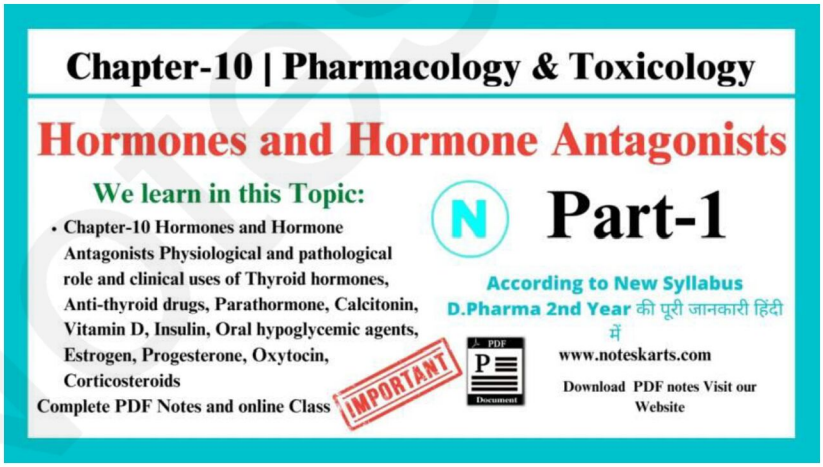
Chapter-10
Pharmacology & Toxicology

D.Pharma 2nd Year Notes

Chapter- 10

Hormones and Hormone Antagonists Physiological and pathological role and clinical uses of

1. Thyroid hormones	7. Oral hypoglycemic agents
2. Anti-thyroid drugs	8. Estrogen
3. Parathormone	9. Progesterone
4. Calcitonin	10. Oxytocin
5. Vitamin D	11. Corticosteroids
6. Insulin	



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Hormones:

- Hormones are chemical messengers that co-ordinate different functions in your body. Several glands, organs and tissues make and release hormones, many of which make up your endocrine system.
- Hormones are produced by glands in the endocrine system that regulate various bodily functions.
- They are released into the bloodstream and travel to target organs or tissues where they exert their effects by binding to specific receptors.
- Scientists have identified over 50 hormones in the human body so far.

Hormone antagonists:

Hormone antagonists are compounds that bind to hormone receptors and block their activation by endogenous hormones.

Physiological Role of Hormone Antagonists:

- Hormone antagonists play a role in regulating the balance of hormones in the body.
- They can also act as feedback inhibitors to prevent excessive hormone production.

Pathological Role of Hormone Antagonists:

- Hormone antagonists can cause hormonal imbalances leading to various diseases, such as infertility, osteoporosis, and cancer.
- Certain hormonal antagonists can also be used to treat these diseases by blocking the action of the hormones involved in their development.

1. Thyroid hormones:

- Thyroid hormones are chemical messengers produced by the thyroid gland, a butterfly-shaped gland located at the base of your neck.
- These hormones, primarily **triiodothyronine (T3)** and **thyroxine (T4)**, are crucial for regulating your body's metabolism, the rate at which your body converts food into energy.

Thyroid releases the following hormones:

- Thyroxine (T4).
- Triiodothyronine (T3).
- Reverse triiodothyronine (RT3).
- Calcitonin.

Physiological Roles:

- Thyroid hormones is important role in regulating metabolism, energy expenditure, and body temperature.
- They also influence heart rate, respiratory rate, and other vital functions.
- They play a role in growth and development, particularly in the development of the brain and nervous system.

Pathological Roles:

- Hypothyroidism occurs when the thyroid gland doesn't produce enough hormones. This can result in a variety of symptoms, including fatigue, weight gain, and sensitivity to cold.
- Hyperthyroidism occurs when the thyroid gland produces too much hormone. This can result in symptoms such as weight loss, rapid heartbeat, and sensitivity to heat.
- Thyroid disorders can be caused by a variety of factors, including autoimmune disorders, iodine deficiency, and certain medications.

Clinical Uses of Thyroid Hormones:

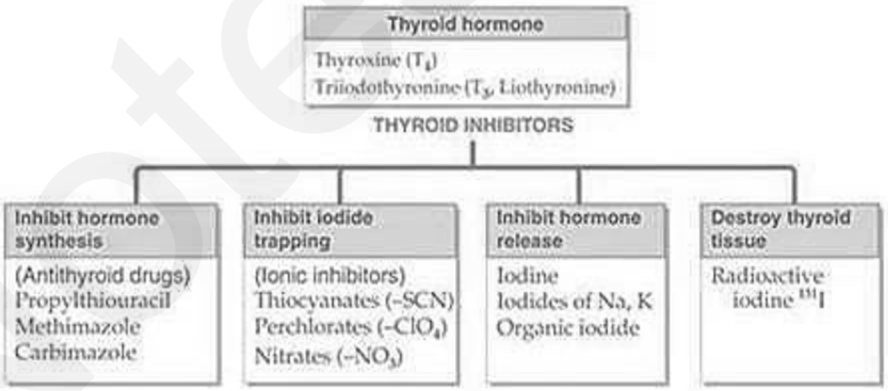
- Thyroid hormone replacement therapy is used to treat hypothyroidism, a condition where the thyroid gland is not producing enough hormones.
- Thyroid hormones can also be used to treat thyroid cancer, by suppressing the production of thyroid-stimulating hormone.

- Thyroid hormones are also used to treat goiter, a condition where the thyroid gland enlarges, by reducing the size of the gland.
- Hyperthyroidism can be treated with medications that reduce thyroid hormone production or block the effects of thyroid hormones.
- Thyroid function tests can be used to diagnose thyroid disorders.
- Radioactive iodine therapy can be used to treat hyperthyroidism by destroying the thyroid gland.

2. Anti-thyroid drugs:

- Anti-thyroid drugs are medications used to treat hyperthyroidism, a condition in which the thyroid gland produces too much thyroid hormone.
- These drugs work by blocking the production of thyroid hormone in the thyroid gland.

Classification of Anti-thyroid Drugs:



The two main types of anti-thyroid drugs are:

- **Thioamides:** Thioamides, also known as thioureas, are the most commonly used anti-thyroid drugs. They work by blocking the enzyme responsible for making thyroid hormone in the thyroid gland. The two thioamides used in the United States are methimazole and propylthiouracil (PTU).

- **Iodine:** Iodine can be used to treat hyperthyroidism, especially if the condition is caused by a condition called thyroiditis. Iodine works by reducing the activity of the thyroid gland, thereby reducing the production of thyroid hormone.

3. Parathormone:

- Parathyroid hormone (PTH) is a polypeptide hormone that the parathyroid glands release to control calcium levels in the blood.
- The parathyroid glands are four small glands located in the neck, behind the thyroid.
- When blood calcium levels drop, the parathyroid glands release PTH to restore balance.

Physiological role:

- PTH increases blood calcium levels by increasing bone resorption, which releases calcium into the bloodstream. It also decreases excretion of calcium by the kidneys and increases absorption of calcium from the intestines.
- PTH stimulates the production of active vitamin D, which promotes intestinal absorption of calcium and phosphate.
- PTH also regulates phosphate levels in the body by decreasing reabsorption of phosphate by the kidneys.

Pathological role:

- Excessive secretion of PTH can lead to hyperparathyroidism, a condition where blood calcium levels are elevated, which can cause symptoms such as weakness, bone pain, and kidney stones.
- Inadequate secretion of PTH can lead to hypoparathyroidism, a condition where blood calcium levels are low, which can cause symptoms such as muscle cramps and seizures.

Clinical uses:

- PTH can be used as a diagnostic tool to differentiate between primary and secondary hyperparathyroidism.
- PTH analogs, such as teriparatide, can be used to treat osteoporosis by increasing bone formation.

- PTH can be used in the treatment of hypoparathyroidism to increase blood calcium levels.

4. Calcitonin:

- Calcitonin is a hormone that helps regulate blood calcium levels. It's a 32-amino acid peptide hormone secreted by the thyroid gland's parafollicular cells, also known as "C cells".
- Calcitonin works by binding to osteoclasts and inhibiting bone resorption, and by reducing calcium and phosphate levels in the blood through its effects on the kidney's tubular epithelium.

Physiological Role:

- Calcitonin helps to regulate calcium and phosphate homeostasis in the body.
- It decreases the concentration of calcium and phosphate in the blood by inhibiting the activity of osteoclasts, which are cells that break down bone tissue and release calcium and phosphate into the blood.
- Calcitonin also increases the excretion of calcium and phosphate in the urine.

Pathological Role:

- Elevated levels of calcitonin can indicate the presence of thyroid cancer, specifically medullary thyroid cancer, as these cancer cells produce excess amounts of the hormone.
- In rare cases, calcitonin can cause hypocalcemia (low levels of calcium in the blood), which can lead to muscle weakness, spasms, and convulsions.

Clinical Uses:

- Calcitonin is used as a medication to treat osteoporosis, a condition in which bones become weak and brittle. It works by inhibiting bone resorption and promoting bone formation.
- It is also used to treat hypercalcemia (high levels of calcium in the blood) associated with malignancy, as it can help to lower blood calcium levels.
- Calcitonin can also be used to relieve pain associated with osteoporosis or vertebral fractures.

5. Vitamin D:

Vitamin D is a fat-soluble vitamin that plays an important role in the body's calcium and phosphate homeostasis. Sources of vitamin D are foods and exposure to sun light, but it biologically inactive , and by hydrolisation process of the body becomes active . Vitamin D3 and D 2 are most essential for Human body.

Physiological Role:

- Vitamin D helps the body absorb and utilize calcium and phosphorus, which are essential for building and maintaining strong bones and teeth.
- It also regulates the immune system and promotes the growth and differentiation of cells, including those in the skin and bone.
- Vitamin D may also have a role in reducing the risk of certain cancers, autoimmune diseases, and cardiovascular disease.

Pathological Role:

- Vitamin D deficiency can lead to rickets in children, which is a condition characterized by weak and deformed bones. In adults, a deficiency can lead to osteomalacia, which causes weak bones and muscle weakness.
- Low levels of vitamin D have also been linked to an increased risk of falls, fractures, and other musculoskeletal disorders.

Clinical Uses:

- Vitamin D supplements are often prescribed to individuals who are at risk of deficiency, such as those with limited sun exposure, older adults, and people with certain medical conditions or medications that interfere with vitamin D absorption.
- Vitamin D supplements may also be used to treat osteoporosis, a condition characterized by weakened bones.
- Vitamin D may have a role in the prevention and treatment of other conditions, such as multiple sclerosis, depression, and chronic pain, but more research is needed to fully understand its potential benefits.

6. Insulin:

Insulin is a hormone produced by the beta cells of the pancreas that important role in regulating glucose metabolism in the body.

Physiological role:

- Insulin helps to regulate blood glucose levels by promoting the uptake and storage of glucose in the liver, muscle, and adipose tissue.
- It promotes the synthesis of glycogen in the liver and muscle, and inhibits the breakdown of glycogen in these tissues.
- Insulin also enhances the uptake of amino acids by the muscle, which promotes protein synthesis and tissue growth.
- Additionally, insulin inhibits lipolysis in adipose tissue, which reduces the release of free fatty acids into the bloodstream.

Pathological role:

- In **type 1 diabetes**, the beta cells in the pancreas are destroyed, leading to a lack of insulin production and uncontrolled hyperglycemia.
- In **type 2 diabetes**, the body becomes resistant to the effects of insulin, leading to elevated blood glucose levels.
- Other conditions such as insulinoma (a rare tumor of the pancreas that secretes excess insulin) and insulin resistance syndromes can also result in abnormal insulin secretion or function.

Clinical uses:

- Insulin is a mainstay treatment for type 1 diabetes and may also be used in certain cases of type 2 diabetes when other medications have failed.
- It may also be used in gestational diabetes and other forms of diabetes that occur during pregnancy.
- In some cases, insulin therapy may be used in critical care settings to manage hyperglycemia and maintain normal glucose levels.
- Insulin may also be used off-label for bodybuilding and athletic performance enhancement, although this practice is not recommended and can be dangerous.

7. Oral hypoglycemic agents:

Oral hypoglycemic agents (OHAs) are medications used to treat type 2 diabetes by lowering blood glucose levels. These agents work by increasing insulin sensitivity, increasing insulin secretion, or reducing glucose production in the liver.

Physiological role:

- OHAs work by improving the body's response to insulin, which is a hormone that regulates blood sugar levels.
- OHAs can reduce insulin resistance and increase insulin sensitivity, which helps the body use glucose more effectively and lower blood sugar levels.
- OHAs can also reduce glucose production in the liver, which can help control fasting blood sugar levels.

Pathological role:

- OHAs are used to treat type 2 diabetes, which is a chronic condition characterized by high blood sugar levels due to insulin resistance and/or insufficient insulin secretion.
- Type 2 diabetes can lead to complications such as cardiovascular disease, kidney disease, nerve damage, and vision loss if not properly managed.

Clinical uses:

- OHAs are used in conjunction with lifestyle modifications such as diet and exercise to manage type 2 diabetes.
- Different types of OHAs are available, including biguanides, sulfonylureas, meglitinides, thiazolidinediones, DPP-4 inhibitors, GLP-1 receptor agonists, and SGLT-2 inhibitors.
- The choice of OHA depends on various factors such as the patient's age, health status, kidney function, and other medications they may be taking.
- OHAs are typically used as first-line therapy for most patients with type 2 diabetes, and insulin therapy may be added later if blood sugar levels are not adequately controlled.
- OHAs can also be used to manage prediabetes and gestational diabetes, which are conditions characterized by elevated blood sugar levels but not as high as in type 2 diabetes.

8. Estrogen:

Estrogen is a hormone produced mainly by the ovaries in women and to a lesser extent by the testes in men. Estrogen plays several physiological roles in the body, and it also has several pathological effects when its levels are not balanced.

Physiological roles of estrogen:

- Development and maintenance of female reproductive organs: Estrogen plays a vital role in the development of female reproductive organs such as the uterus, fallopian tubes, and vagina. It also helps in maintaining the function and health of these organs.
- Development of secondary sexual characteristics: Estrogen is responsible for the development of secondary sexual characteristics in females such as the growth of breasts, distribution of body fat, and changes in body hair.
- Bone health: Estrogen helps maintain bone density and prevent osteoporosis in both men and women.
- Cardiovascular health: Estrogen has a protective effect on the cardiovascular system by reducing the risk of heart disease.
- Brain function: Estrogen has an important role in cognitive function, memory, and mood regulation.

Pathological effects of estrogen:

1. Breast cancer: High levels of estrogen can promote the growth of breast cancer cells.
2. Endometrial cancer: Estrogen can increase the risk of endometrial cancer if the levels are not balanced.
3. Blood clots: Estrogen can increase the risk of blood clots, which can lead to deep vein thrombosis or pulmonary embolism.
4. Ovarian cancer: Estrogen can increase the risk of ovarian cancer.

Clinical uses of estrogen:

- Hormone replacement therapy: Estrogen is used in hormone replacement therapy (HRT) to alleviate symptoms of menopause such as hot flashes, vaginal dryness, and mood swings.

- Contraception: Estrogen is used in combination with progestin as an oral contraceptive.
- Osteoporosis treatment: Estrogen is sometimes used to treat osteoporosis in postmenopausal women.
- Gender-affirming hormone therapy: Estrogen is used in gender-affirming hormone therapy for transgender women to develop feminine characteristics.

9. Progesterone:

Progesterone is a steroid hormone that plays a significant role in the menstrual cycle, pregnancy, and overall reproductive health.

Physiological Role:

1. Menstrual Cycle: Progesterone prepares the uterus for implantation and maintains the lining of the uterus during the second half of the menstrual cycle.
2. Pregnancy: Progesterone important role in maintaining a healthy pregnancy by thickening the uterus lining, preventing the uterus from contracting and helping the body prepare for breastfeeding.
3. Breast Development: Progesterone works with estrogen to promote breast development during puberty and pregnancy.
4. Bone Health: Progesterone is essential for maintaining bone health and reducing the risk of osteoporosis.

Pathological Role:

1. Hormonal Imbalance: A lack of progesterone can cause menstrual irregularities and infertility in women.
2. Miscarriage: Low progesterone levels in early pregnancy can increase the risk of miscarriage.

Clinical Uses:

1. Hormone Replacement Therapy (HRT): Progesterone is used in combination with estrogen in HRT to manage menopausal symptoms, such as hot flashes, vaginal dryness, and mood swings.
2. Infertility Treatment: Progesterone supplements are used to support the early stages of pregnancy in women who have difficulty conceiving.
3. Premenstrual Syndrome (PMS): Progesterone supplements can alleviate symptoms of PMS, such as bloating, breast tenderness, and mood swings.
4. Endometriosis: Progesterone therapy can help to manage the symptoms of endometriosis, such as pelvic pain and heavy periods.
5. Menstrual Disorders: Progesterone is sometimes used to treat menstrual disorders, such as heavy or irregular periods.

10. Oxytocin:

Oxytocin is a hormone produced by the hypothalamus and released from the posterior pituitary gland. It important role in a wide range of physiological processes, including childbirth, lactation, and social bonding.

Physiological Role:

1. **Labor and Delivery:** Oxytocin stimulates uterine contractions, facilitating labor and delivery. It also plays a role in the dilation of the cervix during childbirth.
2. **Lactation:** Oxytocin helps stimulate the let-down reflex, which enables milk to be released from the mammary glands during breastfeeding.
3. **Social Bonding:** Oxytocin has been linked to social bonding, particularly between mother and child, and between romantic partners. It promotes trust, empathy, and affection, which is why it is often referred to as the "love hormone."

Pathological Role:

1. **Autism:** Research suggests that individuals with autism have lower levels of oxytocin, which may contribute to social difficulties and a lack of emotional connection with others.

2. **Anxiety and Depression:** Oxytocin has been shown to have anxiolytic (anti-anxiety) and antidepressant effects in animal models and human studies.
3. **Eating Disorders:** There is some evidence that oxytocin may play a role in the regulation of food intake and body weight, and its use has been explored as a potential treatment for anorexia and bulimia.

Clinical Uses:

1. Induction of Labor: Oxytocin is commonly used to induce labor in women who have gone past their due dates or have medical conditions that require early delivery.
2. Postpartum Hemorrhage: Oxytocin is also used to prevent and treat postpartum hemorrhage by promoting uterine contractions.
3. Breastfeeding: Oxytocin nasal spray has been used to improve lactation and milk ejection in breastfeeding mothers.
4. Autism: Research is ongoing to explore the potential use of oxytocin as a treatment for social and communication difficulties in individuals with autism.
5. Anxiety and Depression: Oxytocin is being investigated as a potential treatment for anxiety and depression, particularly in individuals who do not respond well to traditional medications.

11. Corticosteroids:

Corticosteroids are a class of hormones produced naturally by the adrenal cortex, which play important role in maintaining the normal functioning of the body. They are also available in synthetic form for therapeutic use.

Physiological roles:

- Corticosteroids help regulate the body's metabolism of carbohydrates, fats, and proteins.
- They regulate the body's response to stress, by increasing blood sugar levels, blood pressure, and suppressing the immune response.
- They also play a role in maintaining the balance of salt and water in the body.

Pathological roles:

- Inflammatory disorders such as rheumatoid arthritis, asthma, and other autoimmune disorders can cause inflammation, swelling, and pain. Corticosteroids can help to suppress the immune response and reduce inflammation.
- Allergic reactions can also cause inflammation, and corticosteroids can help to reduce symptoms such as itching, swelling, and hives.
- Corticosteroids can also be used to treat certain types of cancer, by slowing down the growth of cancer cells.

Clinical uses:

- Corticosteroids are commonly used to treat inflammation and pain associated with rheumatoid arthritis, lupus, and other autoimmune disorders.
- They are also used to treat severe allergic reactions, such as anaphylaxis, and to reduce swelling and inflammation associated with asthma and other respiratory conditions.
- Corticosteroids can be used to treat skin conditions such as eczema and psoriasis, and to reduce inflammation and pain associated with certain types of cancer.