ENDOCRINE DISORDERS

(CHAPTERS 37 AND 38)

QUESTION 1

Compare hypersecretion and hyposecretion with receptor resistance.

Hypersecretion and **hyposecretion** occur when **too much** or **too little** of a hormone is present in the body.

Receptor resistance occurs when a hormone **fails** to provoke the desired effect, even if it is present in the correct amount.

QUESTION 2

What distinguishes a "target cell" from other cells of the body?

A **target cell** is a cell which contains **receptors** on its cell membrane that trigger a response to the presence of a specific hormone.

Hormones circulate throughout the body, but only the cells **targeted** by the hormone will actually change their behavior in response to its presence.

Some hormones, such as **insulin**, target cells throughout the body. Others, such as **thyroid-stimulating hormone** (TSH) and **adrenocorticotropic hormone** (ACTH) act only on one type of cell.

If a cell **lacks receptors** for a particular hormone, that hormone **cannot** alter the cell's function.

QUESTION 3

What distinguishes many endocrine disorders from disorders of the other body systems?

The endocrine system is one of the body's **messaging systems**; along with the nervous system, it represents the body's mechanism of allowing distant parts of the body to communicate with each other.

Whereas the nervous system allows near-instant communication between the body and the brain, the endocrine system is **slower**, but allows organs to communicate with each other directly.

Because of this, endocrine disorders can have **many** varied effects throughout the body, in practically every organ. The presentation depends on the function of the particular hormone that is imbalanced.

Whereas many diseases and disorders primarily affect one particular body system, endocrine disorders can affect practically **any** part of the body.

QUESTION 4

Describe the two major forms of treatment for endocrine disorders. Give some examples.

medication – exogenous hormone replacement, chemotherapy for tumors, targeted therapies such as radioactive iodine for hyperthyroidism

surgery – removal of tumors causing imbalances, removal of entire glands/organs (e.g. thyroidectomy, pancreatectomy)

QUESTION 5

What is the underlying cause of diabetes insipidus (DI?) What does the word "diabetes" refer to? How does this relate to the clinical disorder?

The term diabetes comes from the Greek word **diabḗtēs**, meaning "passing through."

This refers to the **excessive thirst** and **excessive urination** experienced by those with diabetes.

The two general categories of diabetes—**diabetes mellitus** and **diabetes insipidus**–mean "sweet diabetes" and "insipid (tasteless) diabetes."

These names refer to one of the major clinical differences between DM and DI—the presence or absence of **glycosuria** (glucose in the urine,) which occurs in DM but **not** in DI.

In general, diabetes insipidus has to do with a **decrease** in the action of anti-diuretic hormone (ADH.)

It's important to remember that, unlike diabetes mellitus, which we usually refer to as just "diabetes," diabetes insipidus **does not involve** insulin or blood glucose levels.

QUESTION 6

Why would an increase in plasma osmolality be seen in diabetes insipidus?

Plasma osmolality (colloidal concentration of the blood) tends to **increase** in diabetes insipidus due to the **excessive loss of fluid** through the kidneys.

Anti-diuretic hormone (ADH) is normally produced in the hypothalamus and released by the pituitary gland in response to **high** osmolality, telling the kidneys to **retain** water.

If this regulation fails and ADH is produced in insufficent quantities, or is "ignored" by the kidneys, fluid loss will **increase** and the blood will become **more concentrated** (higher osmolality.)

QUESTION 7

Describe the three forms of diabetes insipidus. How are they related?

Neurogenic ("nervous system-caused") DI occurs when ADH is **insufficiently produced** by the hypothalamus, or insufficiently released by the pituitary gland.

The lack of ADH leads the kidneys to shed too much water, leading to an increase in urine output and plasma osmolality.

Nephrogenic ("kidney-caused") DI occurs when ADH is produced in appropriate amounts, but the kidneys **fail to respond** to the presence of the hormone.

The kidneys shed water despite being signaled to hold onto it, again leading to an increase in urine output and plasma osmolality.

Dipsogenic ("thirst-caused") DI, a.k.a. **primary polydipsia** occurs when the root cause of the polyuria is due to **excessive fluid intake**, usually due to an increase in the **hypothalamic thirst mechanism**.

The increased thirst drive causes the patient to drink excess water, and the decrease in ADH occurs as a normal physiological response to high blood volume.

QUESTION 8

What are the three main symptoms of diabetes insipidus?

polyuria – increased volume of urine produced, usually very dilute (low specific gravity) due to excess water being lost

polydipsia – increased thirst, either to replace lost water or as the root cause (dipsogenic DI)

dehydration – dry mouth, poor skin turgor, fatigue, etc.

QUESTION 9

Why would water restriction be clinically informative in diabetes?

Diabetes insipidus can be diagnosed with a **fluid deprivation test**, in which the patient is prevented from drinking fluids for several hours and urine concentration is monitored.

If the urine concentration is **still low**, this suggests a problem with **ADH production** (neurogenic DI) or **ADH resistance** (nephrogenic DI.)

If the urine concentration begins to **increase**, this suggests that the problem may have been caused by **excess water intake** (primary polydipsia.)

If the patient is given desmopressin (a synthetic form of ADH) and the urine concentration is **still low**, this suggests the source is **nephrogenic**.

QUESTION 10

Why would hypersecretion of anti-diuretic hormone (ADH) lead to hyponatremia? What is the usual cause?

Hypersecretion of ADH (**too much ADH**, the opposite of neurogenic DI) leads to **hyponatremia** (excess sodium concentration) through excess **water retention** in the kidneys.

ADH signals the kidneys to hold onto water, leading to a decrease of plasma osmolality throughout the body (more water, same quantity of electrolytes.)

This is usually associated with a disorder called **syndrome of inappropriate anti-diuretic hormone secretion** (SIADH.)

Remember that this is sort of the opposite of diabetes insipidus, where low ADH leads to water loss. Here, **high** ADH leads to water **retention**.

QUESTION 11

What tissues are most affected by changes in electrolytes?

Two of the systems most sensitive to electrolyte imbalance are the **nervous system** and the **muscles**, including the **heart**, as both of these rely on ion exchange pumps for proper functioning.

Electrolyte imbalances can lead to neurological symptoms such as **confusion** and **seizures**, as well as **muscle spasm**, **fatigue**, and even **cardiac dysrhythmias**.

QUESTION 12

Which hormones would be affected by panhypopituitarism?

The pituitary gland controls the production or release of many hormones with action throughout the body; **panhypopituitarism** is the underproduction of **all** of these hormones due to pituitary insufficiency.

Affected hormones include:

- **Growth hormone** – stunted childhood development, varied symptoms in adults
- **Adrenocorticotropic hormone** (ACTH) – secondary hypocortisolism (Addison's)
- **Thyroid stimulating hormone** (TSH) – secondary hypothyroidism
- **Gonadotropins** (LH/FSH) – amenorrhea, infertility (in men and women)
- **Oxytocin** and **prolactin** – related to childbirth and lactation

QUESTION 13

What is the usual cause of hyperpituitarism? Why would hyperpituitarism cause visual disturbances?

Hyperpituitarism is normally caused by a **pituitary adenoma**, a benign pituitary tumor.

Visual disturbances from pituitary adenomas are actually **physical** in nature—the pituitary gland lies just superior to the **optic chiasm**, where the optic nerves cross each other after exiting the eyes.

Pressure from the tumor can press on the optic nerves and cause them to malfunction, leading to visual disturbances such as **double vision**.

QUESTION 14

What is acromegaly? What changes are seen in the appearance of a patient? What systemic changes are seen, and why do they accompany acromegaly?

Acromegaly is a disorder caused by the **overproduction** of growth hormone **after** the end of puberty when the metaphyseal plates fuse, halting further bone growth.

Acromegaly is closely linked with the related disorder of **gigantism**, caused by an excess of human growth hormone **before** and **during** puberty.

The word acromegaly literally means "large limbs," as one of the first symptoms is enlargement of the hands and feet.

It can also cause facial changes such as **prognathism** (severe underbite) and skull overgrowth.

Like other forms of hyperpituitarism, acromegaly is commonly caused by a pituitary adenoma.

The **systemic symptoms** of acromegaly are mostly the same as those of hyperpituitarism in general: **fatigue** and **muscle weakness**, **visual disturbances**, **diaphoresis** (excess sweating,) etc.

QUESTION 15

Name the most common secreting tumor of the pituitary. What are the symptoms of this tumor? Why would dopamine agonists be used to treat this condition?

The most common tye of **functional** pituitary tumor is the **prolactinoma**, in which the excess pituitary tissue leads to hypersecretion of the hormone **prolactin**.

The symptoms of excess prolactin tend to be linked to the **reproductive system**: irregular periods or amenorrhea, infertility, decreased libido, galactorrhea, gynecomastia.

The neurotransmitter **dopamine** normally plays a role in regulation of pituitary prolactin production, slowing down or inhibiting production when prolactin is not needed.

Dopamine agonists are drugs which **bind** to dopamine receptors, mimicking the effects of endogenous dopamine. This serves to slow down the pituitary gland, reducing the excess of prolactin released.

QUESTION 16

Compare hypo- and hyperthyroidism, and explain the symptoms of these disorders.

Hyperthyroidism and hypothyroidism refer to excessive or insufficient production of **thyroid hormones**, respectively.

As such, these two conditions have similar but often **opposite** symptoms, as they affect the body in opposite ways.

HYPERTHYROIDISM

- tachycardia
- weight loss
- diaphoresis (excess sweating)
- heat intolerance
- twitchiness, irritability
- increased intestinal motility
- light menstrual periods

HYPOTHYROIDISM

- bradycardia
- weight gain
- dry skin
- cold intolerance
- fatigue, depression
- constipation
- heavy menstrual periods

One notable difference to this pattern is that **both** hyperthyroidism and hypothyroidism can be associated with **goiter**, or swelling of the thyroid.

It presents as a bulging mass in the anterior neck.

This swelling can either be the **cause** of hyperthyroidism, or a **compensation** for hypothyroidism.

QUESTION 17

Name the thyroid hormones. Which is considered the most potent?

The two hormones produced by the thyroid are called **triiodothyronine** (T_3) and **thyroxine** (T_4.)

T_4 levels are normally **much** higher in the blood, but T_3 is much more **potent**, having a far greater effect on cells.

Note that thyrotropin-releasing hormone (TRH) and thyroid-stimulating hormone (TSH,) although related, are **not** thyroid hormones.

TRH is produced in the **hypothalamus**, and triggers the release of TSH from the **pituitary gland**. This in turn triggers the **thyroid** to release the thyroid hormones, T_3 and T_4.

QUESTION 18

What is the underlying pathophysiology of Graves' disease? Does it result in hypo- or hyperthyroidism? What is exophthalmos?

Graves' disease, which we've talked about before in a previous unit, is an **autoimmune** condition (type II hypersensitivity.)

It results when the TSH receptors on the thyrocytes become targeted by the immune system, causing antibodies to be produced which **bind to** the TSH receptors.

These antibodies end up **mimicking** TSH and causing the thyrocytes to become hyperactive because they "think" that they are being stimulated by TSH.

This results in **hyperthyroidism**, as the thyroid is **overstimulated** by this "fake" TSH (the autoantibodies produced by the B plasma cells.)

Exophthalmos results when antibodies bind to the tissues behind the eyes, provoking **inflammation** that causes the eyes to **bulge forward**.

QUESTION 19

What is a thyroid storm? Why would circulatory shock occur as a result?

Thyroid storm is a severe, life-threatening complication of untreated **hyperthyroidism**. It is a **medical emergency** and is often fatal if not promptly addressed.

Extreme excess of thyroid hormones leads to **tachycardia**, greatly **increased blood pressure**, and **high-grade fever** due to accelerated metabolic processes.

During a thyroid storm, the heart beats **so fast** and the blood pressure reaches such a **high level** that the heart no longer effectively circulates blood, leading to **cardiogenic shock**.

QUESTION 20

Compare primary hypothyroidism with secondary hypothyroidism.

Hypothyroidism, like many other endocrine disorders, can have **multiple causes**.

The root cause of low thyroid hormone levels can be in either in **the thyroid itself**, or in the **hypothalamus/pituitary gland** which regulate it.

In **primary hypothyroidism**, the problem is **in the thyroid**. The thyroid is being stimulated, but is not responding to TSH by producing T_3 and T_4 as it should.

As a result, in primary hypothyroidism, TSH levels are **elevated**, as the pituitary gland is trying harder to get the thyroid to respond, but it isn't working.

In **secondary hypothyroidism**, the problem is **in the pituitary gland** or **in the hypothalamus**. The thyroid is functioning normally, but it isn't being stimulated to produce the correct amount of T_3 and T_4.

As a result, in secondary hypothyroidism, TSH levels are **low**, as the pituitary is either failing to produce TSH, or the hypothalamus is failing to stimulate the pituitary gland with TRH.

QUESTION 21

What is myxedema? Describe this condition and its pathophysiology.

Myxedema is a type of **swelling** (edema) which can occur in severe cases of **hypothyroidism**, and occasionally in hyperthyroidism (as in Graves' disease.)

It results from an increased concentration of **proteins** and **polysaccharides** in the extracellular space, increasing IFOP and drawing water out of the cells.

This process results in the formation of **non-pitting edema**, particularly of the **face**, **hands**, and **feet**.

Swelling of the tongue and the mucus membranes of the mouth can result in difficulty speaking and slurred speech.

QUESTION 22

What are the clinical signs and symptoms of cretinism?

Cretinism is a **developmental disorder** caused by thyroid insufficiency at birth, often due to a lack of dietary **iodine** during pregnancy.

If the underlying hypothyroidism is left untreated, it can lead to both **physical** and **mental** underdevelopment throughout childhood.

Better testing and dietary changes (such as the introduction of **iodized salt**) have greatly decreased the incidence of cretinism in the developed world.

QUESTION 23

What are the consequences of hyperparathyroidism? Compare primary and secondary hyperparathyroidism.

The primary effect of hyperparathyroidism is a **decrease in bone density**, due to the action of parathyroid hormone on stimulating **bone resorption**.

If left untreated for a long period of time, this can eventually progress to **osteoporosis** and increased risk of bone fractures.

Primary hyperparathyroidism results from the overgrowth of the parathyroid glands, leading to an excessive production of parathyroid hormone.

This results in a state of **hypercalcemia**, or excessive calcium in the blood, because calcium is being reclaimed from the bones when it is not needed.

Secondary hyperparathyroidism, on the other hand, is the result of a normal physiological response to **hypocalcemia**, usually due to **kidney disease** and the excess loss of calcium in the urine.

In response to low calcium levels, the parathyroid glands initiate the normal response, which is to leech calcium from the bones to fuel the body's needs.

Over time, this can result in serious decreases in bone density, just like primary hyperparathyroidism.

QUESTION 24

What are the consequences of hypoparathyroidism?

The primary effect of hypoparathyroidism is **hypocalcemia**, or insufficient levels of calcium in the blood.

This can lead to abnormal tingling sensations in the extremities, muscle cramps, and tetany. Like other sources of calcium imbalance, it can also cause **cardiac dysrhythmias**.

QUESTION 25

Describe the four general categories of diabetes mellitus (DM.)

The three main categories of DM are **type 1 diabetes**, **type 2 diabetes**, and **gestational diabetes**.

The fourth category, which represents only a small fraction of cases, covers diabetes due to other causes beyond these three main types.

Type 1 diabetes, sometimes called **insulin-dependent diabetes mellitus** (IDDM,) is caused by the destruction of the **beta cells** in the islets of the pancreas, which are responsible for secreting **insulin** into the bloodstream.

This results in **low insulin levels**, causing the cells of the body to fail to take in glucose from the blood to fuel their metabolic needs, which in turn leads to an increase in blood glucose.

Patients diagnosed with type 1 diabetes tend to develop it at a young age, with the average age at diagnosis being around 14.

Type 2 diabetes, sometimes called **non-insulin-dependent diabetes mellitus** (NIDDM,) is caused by insulin **resistance**, meaning that insulin may be produced in normal amounts, but fails to trigger the intake of glucose by the cells.

Like type 1 diabetes, this also results in an elevated blood glucose level. This excess glucose is then excreted in the urine (**glycosuria**,) and water is also lost by osmosis, leading to **polyuria**.

One of the greatest risk factors for the development of type 2 diabetes is **obesity**. Currently, about 90% of diabetes cases fall into the category of type 2 diabetes.

Gestational diabetes is a type of diabetes that develops in non-diabetic women **during pregnancy**, particularly in the third trimester. It **usually** resolves after birth, but can progress to chronic diabetes in a small fraction of cases.

The underlying mechanism is similar to that of type 2 diabetes, featuring insulin resistance, and **obesity** is likewise also a risk factor.

QUESTION 26

What methods are used to screen for and confirm a diagnosis of diabetes mellitus?

- Clinical presentation/**symptoms**
- Elevated **fasting blood glucose**

  (>125 mg/dl, normal is <100)
- Elevated "**random**" (non-fasting) **glucose**

  (>200 mg/dl, normal is <140)
- Potentially, **hemoglobin A1c** above 6.5%

  (normal is <5.7%)

QUESTION 27

Describe the "3 P's" of diabetes mellitus. Why would a patient's breath smell of acetone? What is ketoacidosis?

polyuria – increased volume of urine, in this case due to glycosuria causing fluid loss

polydipsia – increased sensation of thirst, in this case secondary to fluid loss

polyphagia – increased hunger, in this case due to cells being unable to access glucose for energy

One of the **major risks** of untreated diabetes (particularly type 1) is **diabetic ketoacidosis** (DKA.)

DKA occurs when insulin levels are significantly too low, and cells are unable to obtain glucose to fuel their energy needs.

Cells begin to break down fatty acids for energy instead, producing acidic **ketones** as a byproduct.

If the ketones in the blood build up faster than the body can excrete them, this results in **metabolic acidosis**, which can be life-threatening if not treated.

An **acetone scent** to the breath can be a sign of the presence of ketones in the blood, which **may** be a sign that the patient is at risk for DKA.

QUESTION 28

Which patients must take insulin, and why is it given subcutaneously?

Exogenous insulin replacement is required by **all** patients with type 1 diabetes, and may be required in **some** patients with advanced type 2 diabetes, as their pancreatic islets can also suffer damage over time.

Insulin is given via subcutaneous injection because it must reach the bloodstream intact in order to be usable by the cells.

Insulin is a **peptide** (small protein) which would be denatured by the acidic environment of the stomach, thus it cannot be given orally and remain effective.

QUESTION 29

What are the risk factors for type 2 diabetes mellitus?

- **Obesity**, high blood pressure, high triglycerides, low HDL

  (a.k.a. "metabolic syndrome")
- **Age**
- **Family history**
- **Race**: African American, Hispanic, or Native American

QUESTION 30

Describe the metabolic changes that occur in type 2 diabetes mellitus.

Insulin resistance causes the body's cells to be unable to access glucose as an energy source, resulting in elevation of blood sugar and the use of alternate energy sources such as fatty acids.

Over time, those with type 2 diabetes often begin to develop insulin **deficiency** as progressive beta cell dysfunction worsens, leading to the need for insulin supplementation.

QUESTION 31

Describe some of the acute complications of diabetes. What are the Somogyi effect and the dawn phenomenon?

hyperglycemia – from insufficient correction of blood glucose levels

hypoglycemia – from **overcorrection** of blood glucose

(e.g. taking too much insulin relative to the amount of food consumed)

diabetic ketoacidosis (DKA) – primarily in T1DM

hyperosmolar hyperglycemic state (HHS) – primarily in T2DM

The **dawn phenomenon** or **dawn effect** occurs when blood glucose rises sharply in the early morning, often due to eating extra carbs before bed or taking insulin too early at night so there is not enough left over in the morning.

The **Somogyi effect** is similar, but occurs when blood sugar drops **too low** during the night and there is a "**rebound high**" in the early morning when the body overcorrects.

QUESTION 32

Describe neuropathy and nephropathy. Compare micro- and macrovascular disease. Describe retinopathy.

Long-term elevation of blood glucose can cause **permanent damage** to the blood vessels; this falls into the categories of:

macrovascular disease – affecting the large vessels, e.g. peripheral vascular disease, CAD

microvascular disease – affecting smaller vessels, e.g. neuropathy, nephropathy, and retinopathy

Diabetic neuropathy occurs when damage to the small blood vessels results in **ischemia** to the nerves, particularly in the **lower extremities**.

This can result in numbness, tingling, or pain in the legs and feet, and in severe cases can also affect the autonomic nervous system.

Diabetic nephropathy (or **diabetic kidney disease**) occurs when damage to blood vessels causes damage to the renal glomeruli, often resulting in **proteinuria**.

Diabetic nephropathy is one of the most common causes of chronic kidney disease (CKD,) making diabetes a huge risk factor for kidney failure.

Diabetic retinopathy (or **diabetic eye disease**) occurs when damage to blood vessels in the eyes damages the **retina**, which can lead to a loss of visual acuity and even blindness.

Some degree of retinopathy is extremely common in those who have suffered from diabetes long-term, and is a leading cause of acquired vision loss.

QUESTION 33

What is gestational diabetes? What does the placenta have to do with this?

Gestational diabetes, as we talked about in a previous question, is a (usually temporary) form of **insulin resistance** that develops in some women **during pregnancy**.

It occurs because some of the hormones produced by the placenta, including **human placental lactogen** (HPL) have a suppressive effect on insulin, creating an effect that mimicks type 2 diabetes.

This effect increases in the **later stages** of pregnancy as the fetus matures and more hormones are produced. The problem **usually** resolves itself after the baby is delivered.

QUESTION 34

What would you expect to see in primary Cushing's syndrome (hypercortisolism?) What about secondary Cushing's syndrome?

Cushing's syndrome refers to a group of symptoms associated with **hypercortisolism**, the excess of **glucocorticoids** in the body.

It can be caused by either an internal problem in the body, such as **Cushing's disease**, or by **prolonged glucocordicoid therapy**.

In **primary** hypercortisolism, the problem is directly in the **adrenal cortex**. Because of this, **adrenocorticotropic hormone** (ACTH) levels will be **low**, as the pituitary gland is trying to slow down the adrenal gland, but it isn't working.

In **secondary** hypercortisolism, the problem is in the **pituitary gland**. This will result in ACTH levels being **high**, because the pituitary gland is overproducing ACTH and the adrenal cortex is simply responding to the high ACTH levels.

QUESTION 35

What are the clinical signs and symptoms of Cushing's syndrome?

Some of the signs and symptoms can include **abdominal obesity** with stretch marks, a buildup of fat around the face known as "**moon face**," **hirsutism**, and **fatigue**.

A good mnemonic for this is that "Cushing's" sounds like "cushion"—too much cortisol makes you puffy and fuzzy like a pillow. 😂

QUESTION 36

What is the pathophysiology of congenital adrenal hyperplasia? Which hormone class is elevated, and which hormone is reduced?

Congenital adrenal hyperplasia (CAH) is a group of inherited disorders that cause the inability of the adrenal glands to produce certain hormones, resulting in **compensatory hyperplasia**.

The exact presentation depends on the particular form of CAH, but **corticosteroids** such as **cortisol** and **aldosterone**, as well as **sex hormones** are affected.

In the most common form, **corticosteroids** are produced in smaller amounts, but **androgens** (male sex hormones, e.g. testosterone) are unaffected by the mutation and thus are produced in **larger** amounts by the enlarged adrenal gland.

Lack of aldosterone leads to fluid and sodium loss through the urine, and excess androgens can cause problems with **sexual development** in girls (ambiguous genitalia at birth, delayed or absent puberty, infertility.)

QUESTION 37

Describe hyperaldosteronism. Which electrolytes are altered? What are the consequences?

Hyperaldosteronism is the secretion of **excess** aldosterone by the adrenal glands. This has a significant affect on the **kidneys** and fluid/electrolyte balance.

The primary electrolytes altered are **sodium** and **potassium**, which are exchanged in the kidney tubules in response to aldosterone levels.

Aldosterone triggers the **reabsorption** of sodium in **exchange** for potassium, meaning that high aldosterone levels lead to **hypernatremia** and **hypokalemia**.

QUESTION 38

What are the clinical signs and symptoms of hyperaldosteronism?

The consequences of this electrolyte imbalance are the same as with any other source of hypernatremia or hypokalemia:

too much sodium -> **high blood pressure**, **polydipsia**, **polyuria**

not enough potassium -> **muscle weakness**, **fatigue**, **spasms**

QUESTION 39

Is Addison's disease common? What is the underlying problem in this condition? What hormone levels are altered?

Addison's disease refers to **hypocortisolism**, essentially the "opposite" of Cushing's syndrome.

It is a **rare** condition usually caused by **autoimmune damage** to the adrenal glands (**primary adrenal insufficiency**,) resulting in decreased production of adrenal hormones.

Hypocortisolism can occasionally be caused by **secondary adrenal insufficiency**, in which the adrenal glands receive insufficient stimulation from the hypothalamus and pituitary gland.

This results in a decrease of **all** of the adrenal hormones: **mineralocorticoids** (aldosterone,) **glucocorticoids** (cortisol,) and **androgens** (testosterone.)

ACTH levels may be either **high** or **low** depending on the underlying cause (primary or secondary.)

QUESTION 40

In secondary Addison's disease, is adrenocorticotropic hormone (ACTH) high or low? What about in primary Addison's disease? Which electrolyte reaches dangerously high levels, and why?

In **primary** hypocortisolism, ACTH levels are **high** because the pituitary gland is trying to **speed up** the adrenal glands, but it isn't working because of the adrenal damage.

In **secondary** hypocortisolism, ACTH levels are **low** because the adrenal gland is working properly but is being **understimulated** by the pituitary gland.

In both forms of hypocortisolism, **potassium** can reach dangerously high levels (hyperkalemia,) due to the relative lack of **aldosterone** production and the failure to expel potassium in the urine.

This is particularly dangerous because high potassium levels can lead to **cardiac dysrhythmias** which can become life-threatening if untreated.

QUESTION 41

What are chromaffin cells, and where are they found? What is a pheochromocytoma, and what are the associated clinical signs and symptoms?

Chromaffin cells (or **pheochromocytes**) are secretory cells located in the adrenal medulla, just below the cortex of the adrenal glands.

Rather than producing corticosteroids, the chromaffin cells produce **catecholamines**, such as **epinephrine** and **norepinephrine**.

A **pheochromocytoma** is a tumor of the adrenal medulla, which results in the **excessive** production of catecholamines.

The primary result of this excess of epinephrine and other catecholamines is **hyperactivity** of the **sympathetic nervous system** ("fight or flight.")

This can include **anxiety**, **elevated blood pressure**, and **elevated blood glucose level**.