The Endocrine System 2

Continuing on from the previous instalment, we will now look at the adrenal glands, the pancreas and the gonads as parts of the endocrine system.

Adrenal Glands

The adrenal glands are two pyramid shaped glands, one found on the top end of each kidney. Each adrenal gland is made up of two glands – the inner medulla and the outer cortex.

1. Adrenal Cortex – secretes steroid hormones
   a. Cortisone increases the body’s ability to resist stress. It is an anti-inflammatory and anti-allergen
   b. Aldosterone causes increased reabsorption of sodium ions from the filtrate in the kidney nephrons and the movement of potassium ions into the filtrate. It therefore regulates the electrolytic levels of body fluids

Cortical activity is controlled by a complex chain of reactions, triggered by the hypothalamus when aldosterone levels are low. The hypothalamus secretes releasing factors to stimulate the anterior lobe of the pituitary gland to release the hormone ACTH, which then travels to the adrenal cortex, stimulating it to release aldosterone and other hormones.

2. Adrenal Medulla
   a. Adrenalin is also known as the ‘fight or flight’ hormone. It is secreted in situations of sudden danger or excitement, and prepares the body for action. Adrenalin has the same effects as the sympathetic nervous system:
      i. Blood pressure increases as blood vessels narrow in the skin and alimentary canal (digestive system). This allows more blood to go to the skeletal and cardiac muscles
      ii. Blood sugar levels are increased because liver glycogen is converted to glucose. This glucose is released into the blood stream, ready for use in cellular respiration
      iii. Oxygen content of blood is raised because the rate and depth of breathing are increased. This extra oxygen is also needed for increased cellular respiration, which results in the release of more energy
      iv. Heart rate increases. This sends the glucose and oxygen-rich blood to the muscles quicker, where cellular respiration increases, making more energy available
      v. Skeletal muscle tone is increased allowing quicker responses
   b. Other effects include:
      i. Dilation of pupils for better vision (this also occurs when we see the person we fancy)
      ii. Increased sweating for increased cooling
      iii. Reduction of digestive activities
      iv. Increased mental alertness, allowing for greater awareness and quicker thinking
Pancreas

The pancreas is unusual as it functions as both an exocrine and endocrine gland:

- The **exocrine** function is the secretion of pancreatic juice, which flows through the pancreatic duct into the duodenum (intestine) where it assists chemical digestion
- The **endocrine** function is the secretion of hormones by groups of cells known as **islets of Langerhans**. These are scattered throughout the pancreas, and are made up of two different types of cells, which secrete two different hormones. These are the **alpha cells** and the **beta cells**
  - **Alpha cells** secrete glucagon
  - **Beta cells** secrete insulin

Both of these hormones control the level of glucose in the blood. In a healthy human, normal glucose concentration is between 3.5 and 5.5 mmol/litre of blood (milli-moles per litre). Glucose is the primary source of cellular energy and is transported throughout the body by the blood, though it cannot enter cells without the aid of **insulin**.

- **Insulin**, therefore, **lowers** the blood sugar level
- **Glucagon** raises the level of blood sugar
- These two hormones have antagonistic (opposite) effects

1. **Insulin** lowers blood glucose level:
   a. After a meal containing carbohydrates, glucose from digested food is absorbed from the small intestine and moves into the blood
   b. As this blood passes through the pancreas, the **beta cells** detect the increased glucose levels and secrete insulin into the blood
   c. The main target organs (the liver and the muscles), its effects include
      i. Making cell membranes more permeable to glucose
      ii. Increasing the rate at which glucose is converted into glycogen in the cells, encouraging more glucose to enter the cells. Glucose can also be stored as fat under the skin
   d. These processes take glucose out of the blood, lowering the blood glucose level. This is detected by the **beta cells** which then stop releasing insulin into the blood

2. **Glucagon** increases blood glucose level:
   a. Glucose levels are low after waking up in the morning or after exercise
   b. As blood with low glucose levels passes through the pancreas, the **alpha cells** detect the glucose levels and secrete glucagon into the blood
   c. The glucagon affects the liver cells, causing the breakdown of stored glycogen into glucose
   d. The liver releases glucose into the blood, increasing the blood glucose level. This is detected by the **alpha cells**, which then stop secreting glucagon.
3. **Sugar Diabetes (diabetes mellitus)** is a chronic disease characterised by high levels of glucose in the blood. Approximately 6 million South Africans suffer from the disease, of which 90% are adults and the other 10% children. There are several forms of sugar diabetes, but **Type 1** and **Type 2** are the most common

a. **Type 1** (insulin dependent) usually starts in childhood and accounts for 5 to 10% of diagnosed cases. The initial symptoms are
   
   i. Tiredness
   
   ii. Production of large amounts of dilute urine containing glucose – kidneys cannot reabsorb extra glucose
   
   iii. Thirst due to loss of liquid

   It is an autoimmune disease, meaning that the body's own immune system attacks the body itself. In this case, the immune system destroys the insulin-producing beta cells. This results in the pancreas not producing insulin, which leads to glucose remaining in the blood, causing a condition known as hyperglycaemia

   Type 1 diabetes is a life-long disease for which there is no cure. If the patient is disciplined and responsible, however, the disease can be controlled
   
   - Little or no insulin is being produced, so the most important treatment is following a daily routine of insulin injections
   
   - The diabetic must frequently test their blood sugar levels with a finger-prick test so they can administer the correct amount of insulin

   If left untreated, in the short term it can lead to thirst, nausea, vomiting, dizziness, dehydration and, potentially, falling into a coma. The goals of treatment are to prolong life and prevent complications such as blindness, renal (kidney) failure and increased risk of heart attacks and strokes.

b. **Type 2** (non-insulin dependent) usually starts in adulthood and is directly influenced by lifestyle. It is far more common than type 1, accounting for 90 to 95% of cases. The symptoms tend to develop gradually, so many people are not aware they suffer from the disease. Warning signs include:

   i. Increased thirst
   
   ii. Frequent urination
   
   iii. Blurred vision
   
   iv. Tingling or numbness in hands or feet
   
   v. Frequent infections and slow-healing wounds

   Factors that increase the risk of developing type 2 diabetes include:

   i. Increasing age
   
   ii. A diet high in sugars, fats and over-processed food, leading to obesity (which is a prominent cause of type 2 diabetes)
   
   iii. Lack of exercise (a sedentary lifestyle)
It is caused when the body produces less insulin or cannot use it correctly. This may be due to faulty insulin receptor cells that aid in the transportation of glucose into cells, a condition known as insulin resistance.

It can be treated by:
- Following a balanced diet
- Eating low GI (glycaemic index) carbohydrates – this helps to control blood glucose levels
- Losing weight
- Regular exercise
- Sometimes, insulin may be taken

(glycaemic index is a measure of the impact of carbohydrates on blood glucose levels. Carbohydrates that break down quickly during digestion release glucose into the blood stream rapidly, causing dangerously high levels. These have a high GI. Carbohydrates that break down more slowly, releasing glucose more gradually, have a low GI)

Gonads (reproductive organs)

The gonads in females are the ovaries and, in males, the testes. They produce gametes (sex cells) and also secrete sex hormones.

1. Ovaries
   a. Oestrogen
      i. Rapid increase in physical growth during puberty
      ii. Appearance of secondary sexual characteristics at puberty
      iii. Maturation of reproductive organs and maintaining a functional state
      iv. With progesterone, promotes cyclical changes to the endometrium during the menstrual cycle. This means that it prepares the endometrium for pregnancy – the endometrium become more glandular and vascular and the cells swell with nutrients

      As oestrogen levels increase, the release of FSH and LH is inhibited. This is the basis of birth control tablets – with no FSH, no egg can be formed. Once oestrogen levels are high, the release of FSH and LH is not prevented, but promoted. This is called positive feedback.

   b. Progesterone
      i. With oestrogen, prepares endometrium for pregnancy
      ii. During pregnancy, it maintains the endometrium in a functional state
2. **Testes**
   a. Situated in the scrotum, the testes secrete **testosterone**, which is responsible for:
      i. Rapid increase of physical growth during puberty
      ii. Development of secondary sexual characteristics during puberty
      iii. Maturation of reproductive organs and maintaining them in a functional state
      iv. Sex drive

**Hypersecretion** of reproductive hormones causes:

- Premature onset of puberty
- Masculine features become evident in adult woman (**virilism**)