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A2 Biology OCR

Unit F214: Communication, Homeostasis and Energy

Module 1.3 Hormones

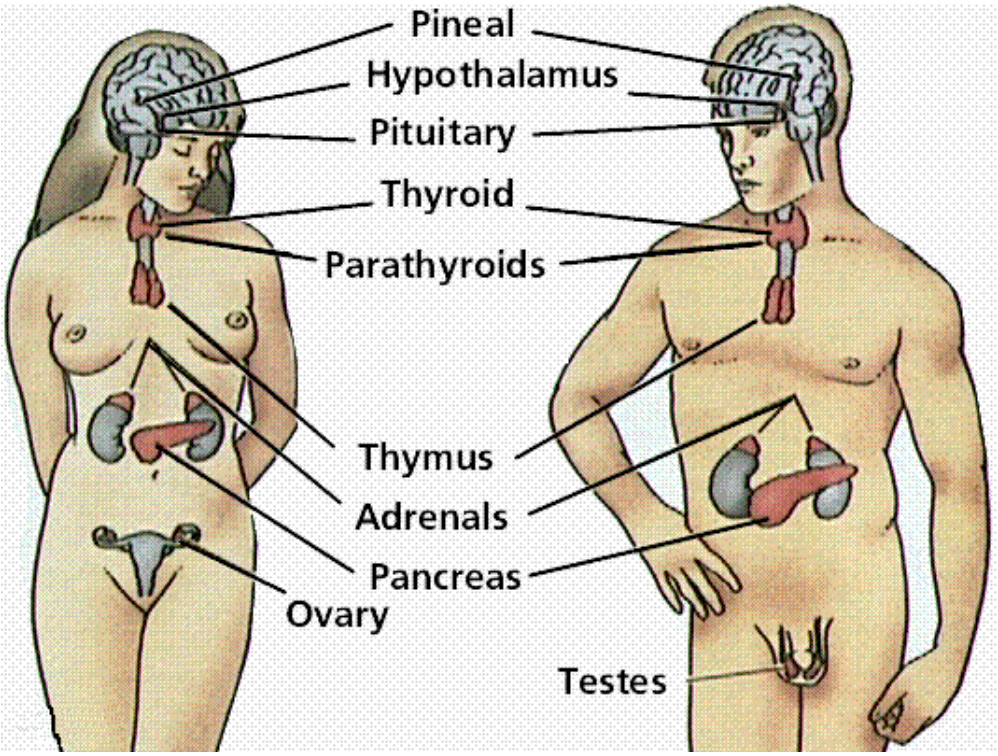
Notes

Define the terms *endocrine gland*, *exocrine gland, hormone* and *target tissue*.

- **Gland**
  - A organ in an animal whose tissue synthesises and releases a chemical into the animals blood stream or into ducts.
- Exocrine gland
  - Synthesises and secretes chemicals
  - into ducts
  - Example: enzymes, saliva, sweat
- Endocrine gland
  - Synthesises and secretes hormones
  - Directly into the blood
  - Example: adrenaline
- Hormone
  - A molecule that is released directly into the blood from endocrine tissue
  - Acts as a chemical messenger released from part of the body and affect target cells in other parts of the body
  - Only a small amount is needed to alter the cell metabolism/function
- Target tissue
  - Can be individual cells or cells in a tissue.
  - Calls have receptors inbedded in the membrane that are complementary in shape to the specific hormone molecules
  - Only these cells will respond to that specific hormone

Explain the meaning of the terms *first messenger* and *second messenger*, with reference to adrenaline and cyclic AMP (cAMP).

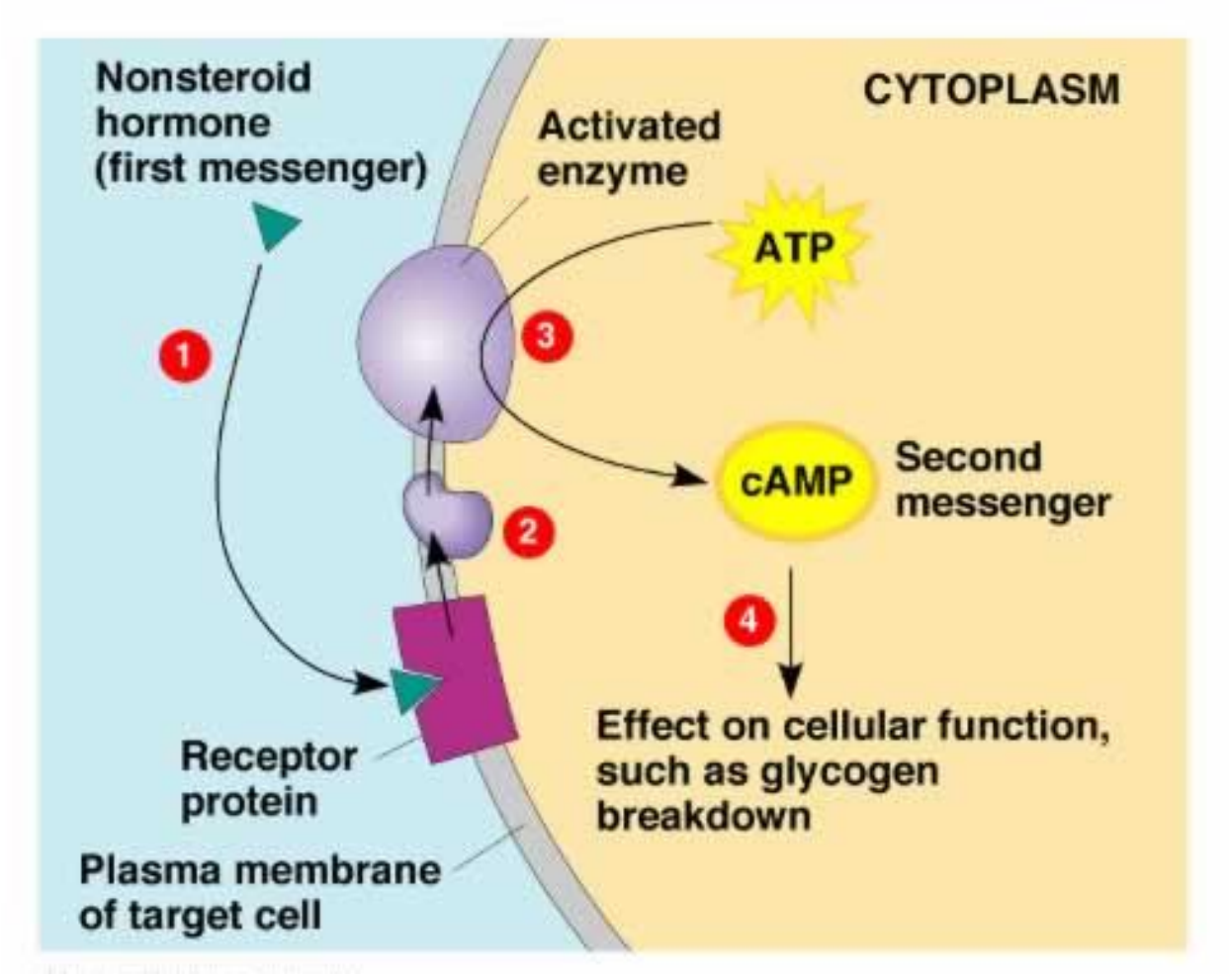
- **Endocrine Glands**



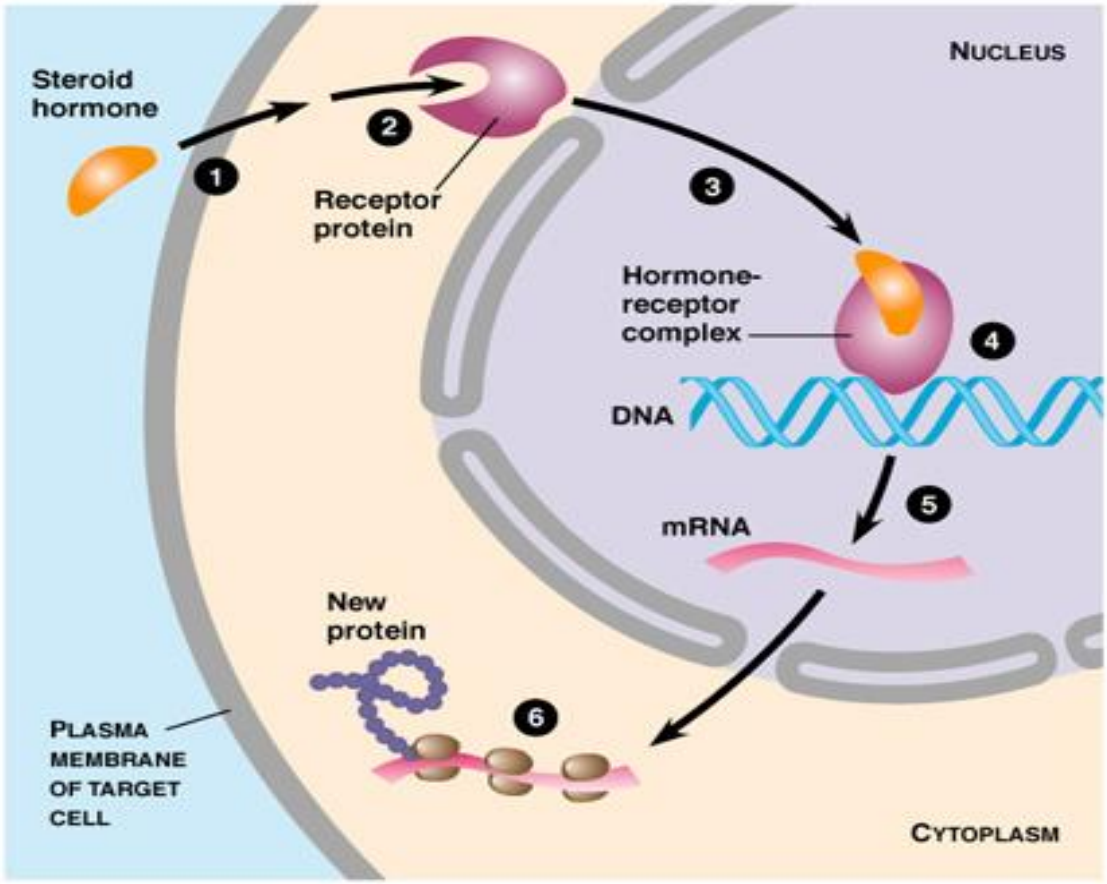
- **Hormones**
  - There are two types of hormone
    - Protein / Polypeptide Hormones
    - Steroid Hormones

  - **Protein / Polypeptide Hormones**
    - Adrenaline, insulin, glycogen
    - Cannot pass through the plasma membrane of target cell
    - Made up of amino acids, soluble in water
    - Combine with receptor hormones on the cell membrane
    - Hormone-receptor complex on the cell membrane induces an internal response by the cell which results in protein synthesis

  - Protein / Polypeptide hormones are referred to as first messengers.
    - They are the initial messengers in cell to cell communication
    - When hormones bind to receptor sites, the complex activates the enzyme adenyl cyclase
    - Adenyl cyclase converts ATP to cyclic AMP (cAMP)
    - cAMP is referred to as the second messenger as it will go on to activate other enzymes

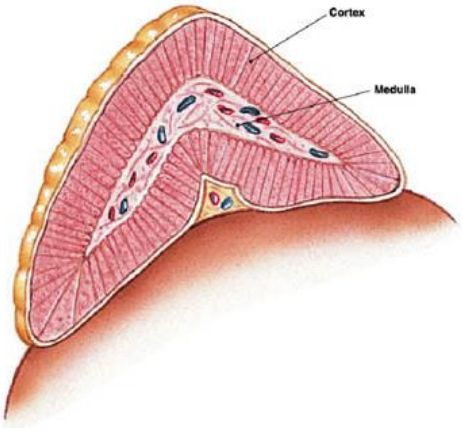


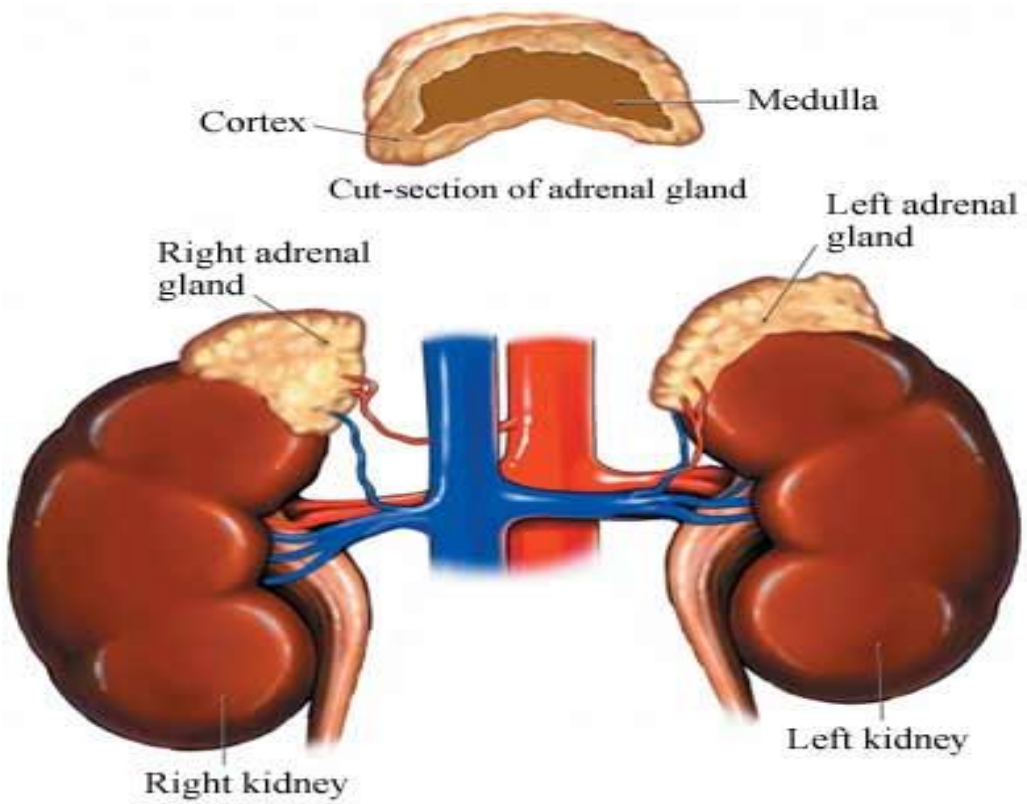
- **Steroid Hormones**
  - Sex hormones (E.g testosterone)
  - Many fused rings of carbon, hydrogen, oxygen, not soluble in water
  - Diffuse through cell membrane and combine with receptor protein in cytoplasm
  - Hormone-receptor complex inside plasma membrane causes cell to respond to hormone by interacting with cell DNA and stimulating protein synthesis

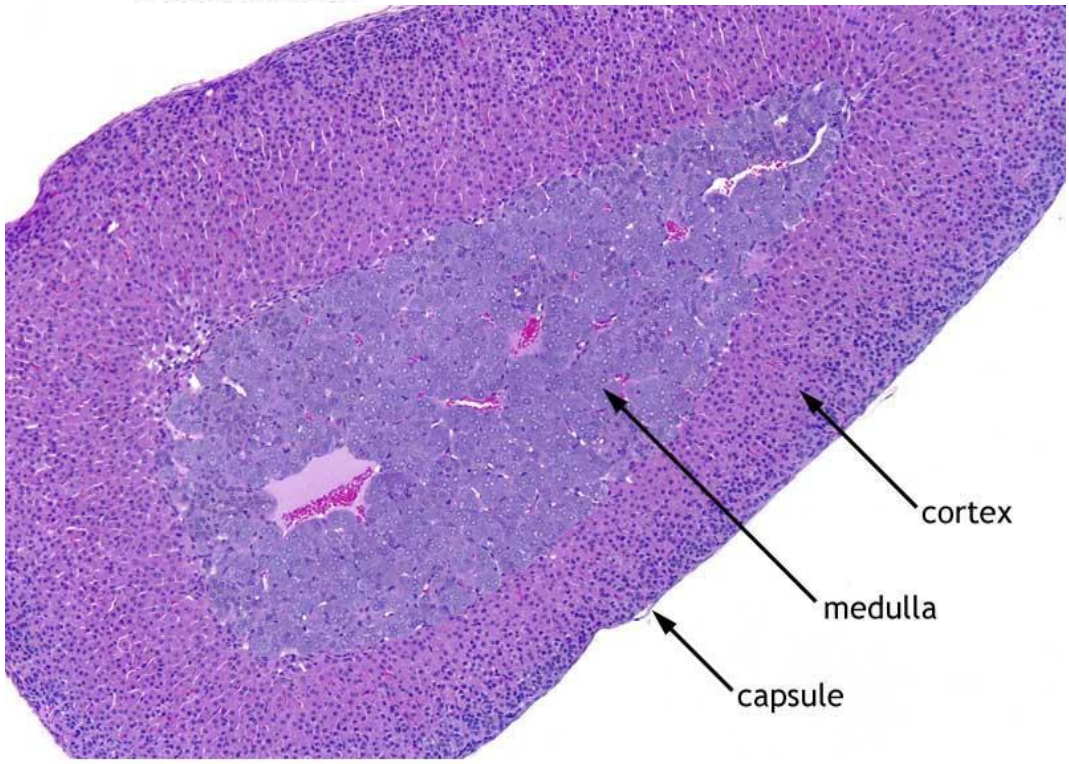


Describe the functions of the adrenal glands.

- **The adrenal gland**
  - There are two regions of the adrenal gland
  - The inner region – The adrenal medulla
  - The outer region – The adrenal cortex




Cortex
Medulla
Cut-section of adrenal gland
Left adrenal gland
Right adrenal gland
Left kidney
Right kidney

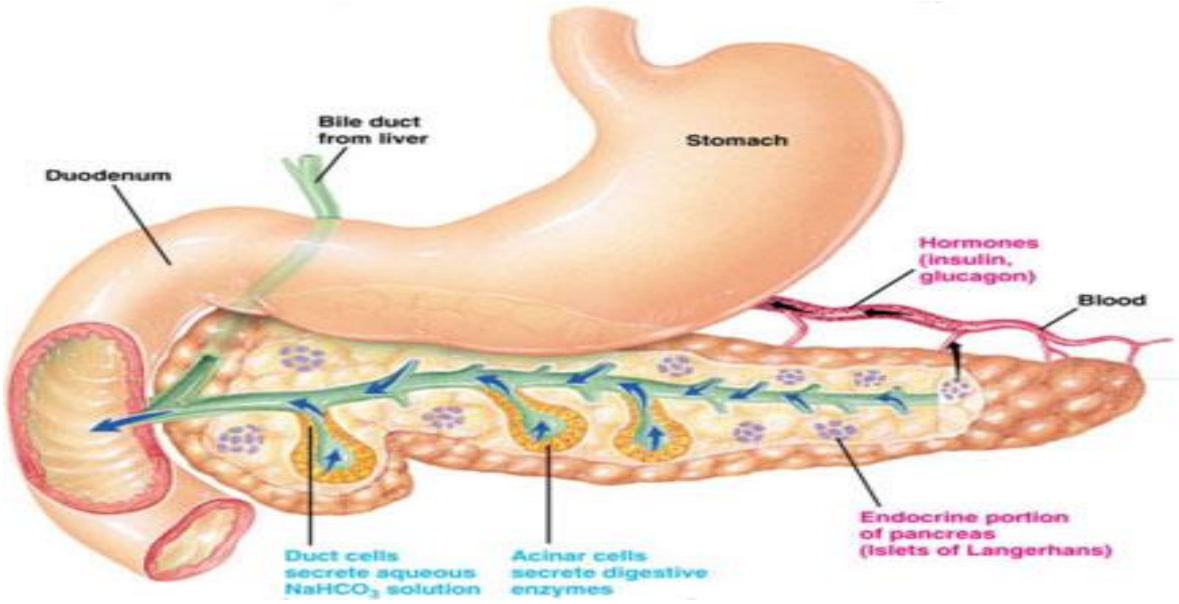

cortex
medulla
capsule

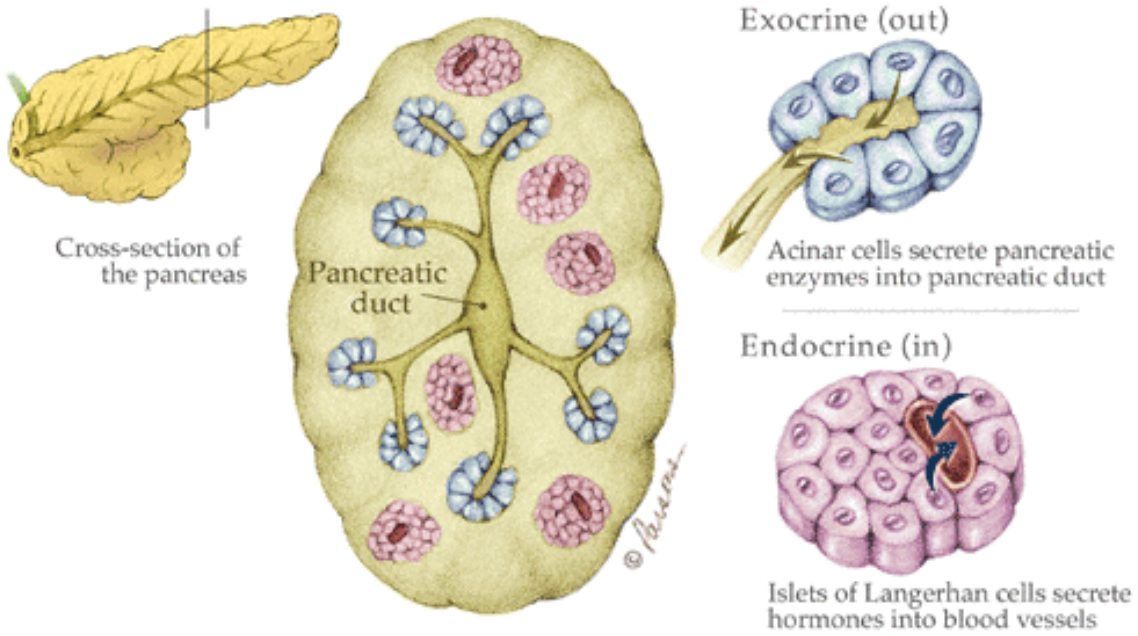
- **Adrenal Medulla**
  - Manufactures and releases <u>adrenaline</u> (Protein Hormone) in response to pain and/or shock
  - Adrenaline prepares the body for activity by;
    - Relaxing smooth muscles around the bronchioles
    - Increasing heart stroke and volume
    - Vasoconstriction and increase blood pressure
    - Inhibit gut action
    - Hairs are erected
    - Pupils dilate
    - Increases mental alertness/awareness

- **Adrenal Cortex**
  - Uses cholesterol to create steroid hormones
  - <u>Mineralocorticoids</u> (E.g. Aldosterone)
    - controls Na and K in blood
  - Increases blood pressure
  - <u>Glucocorticoids</u> (E.g Cortisol)
    - Controls the metabolism of carbohydrates
    - Increases energy release
    - Increases blood pressure
    - Decreases immune responses

Describe, with the aid of diagrams and photographs, the histology of the pancreas, and outline its role as an endocrine and exocrine gland.

- The Pancreas is a small organ situate below the stomach
- It has both endocrine and exocrine glandular tissue

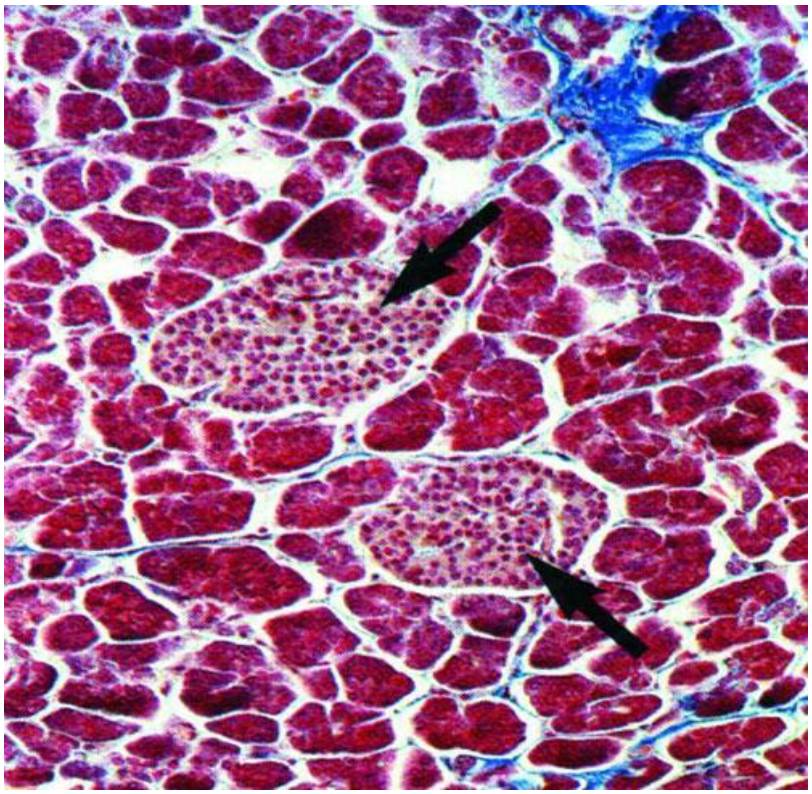


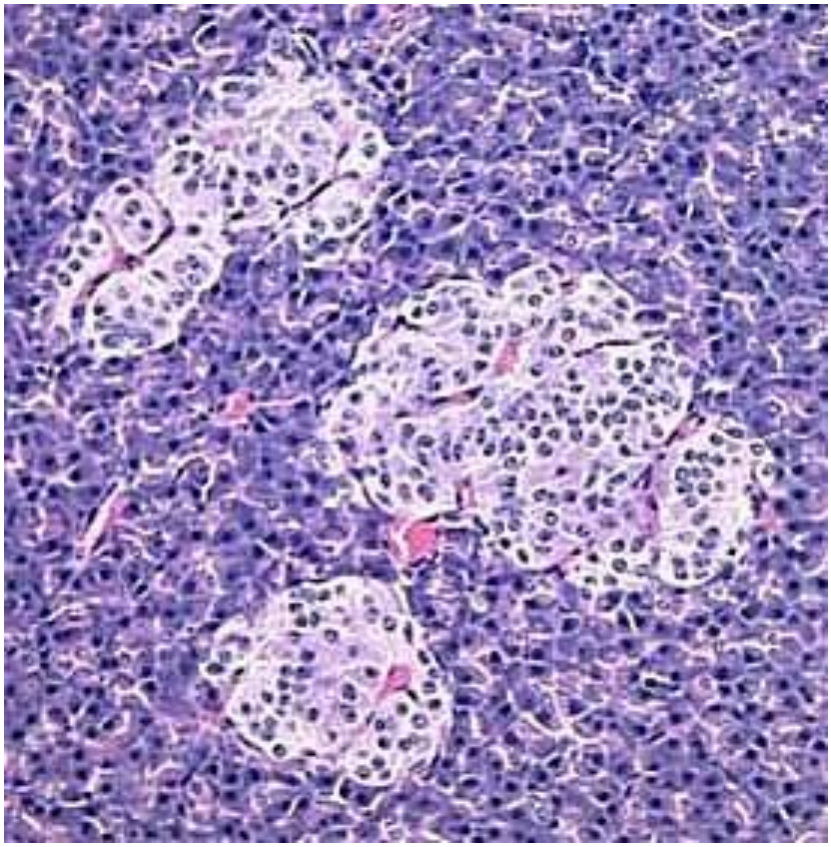


- **The pancreas as an Exocrine gland**
  - Majority of cells are involved in being an exocrine gland
  - Small groups of cells surround tiny tubules
  - Cells release
    - sodium hydrogencarbonate
    - Digestive enzymes, such as
      - Amylase
      - Inactive Protease
      - Lipase
  - Tiny tubules join up and create a large duct known as the pancreatic duct

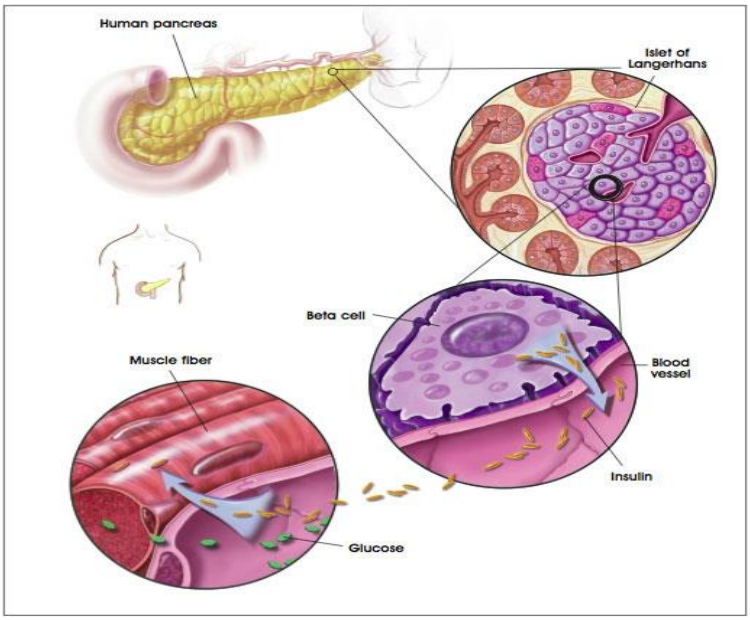
- **The pancreas as an Endocrine gland**
  - Specialised areas of the pancreas known as Islets of Langerhans.
  - Islets of Langerhans contain two types of cells
    - α Cells & β Cells
    - α Cells make and secrete the hormone Glucagon
    - β Cells make and secrete the hormone Insulin
  - Islets have a good blood supply for transporting the hormones

- The endocrine tissue of the pancreas are the alpha and beta cells of the islets of langerhans.





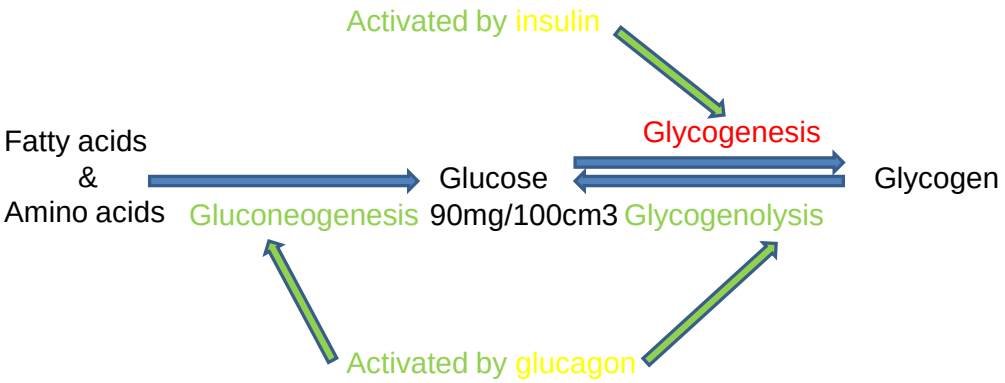
Explain how blood glucose concentration is regulated, with reference to insulin, glucagon and the liver.



- **Insulin**
  - Released from beta cells in the islets of Langerhans
  - Insulin is a hormone that causes cells in the liver, muscle, and fat tissue to take up glucose from the blood,
  - Converting and storing it as glycogen in the liver and muscle,.
  - Increasing respiration of carbohydrates
  - Stopping use of fat as an energy source.
  - Suppressing the release of glucagon

- **Glucagon**
  - Released from alpha cells in the islets of Langerhans
  - Glucagon is an important hormone. Produced by the pancreas, it is released when blood glucose levels start to fall too low, causing the liver to convert stored glycogen into glucose and release it into the bloodstream.
  - Raising blood glucose levels and ultimately preventing the development of hypoglycemia.
  - The action of glucagon is thus opposite to that of insulin.
  - Increasing respiration of fats
  - Reducing the use of carbohydrates as an energy source.
  - Suppressing the release of insulin.

Glucose, Glucagon, Glycogen, Glycogenesis, Gluconeogenesis & Glycogenolysis

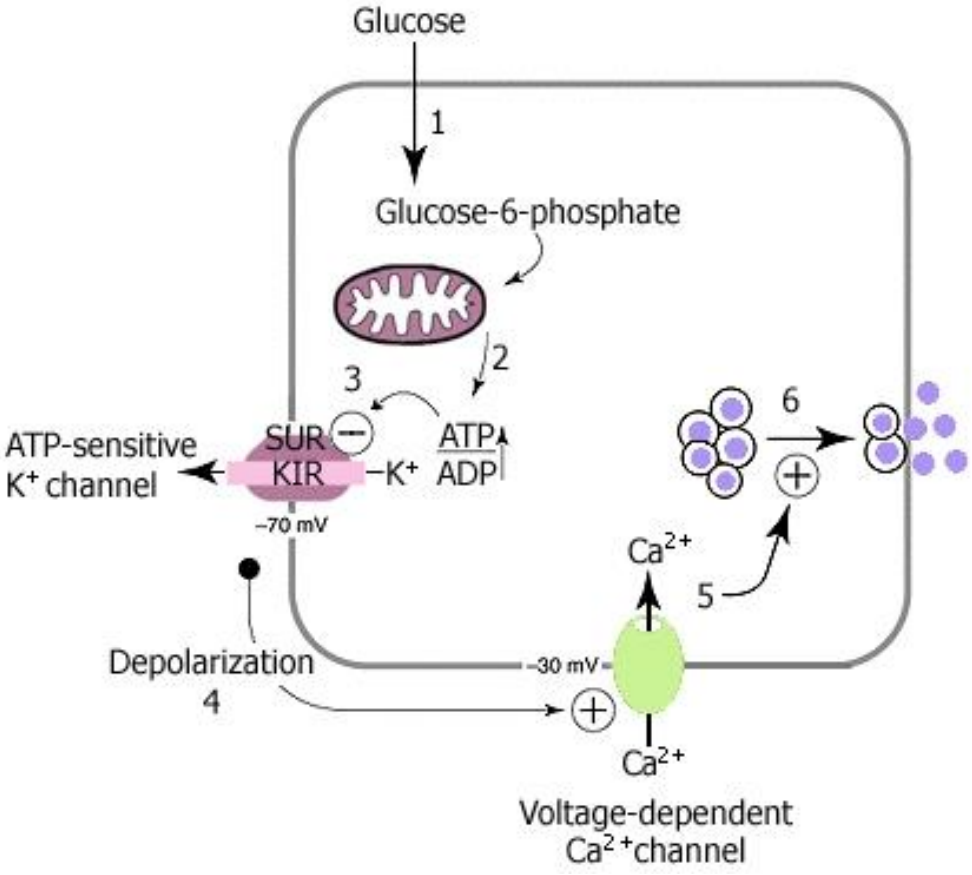


Outline how insulin secretion is controlled, with reference to potassium channels and calcium channels in beta cells.

- Insulin is released from beta cells in the islets of langerhans when glucose concentration is high in the blood.
- If blood glucose concentration drops then it is important that insulin secretion also drops.
- Beta cells monitor blood glucose concentration and secrete the required level of insulin into the blood.
- Beta cells in the islets of langerhans detects the increase in the blood glucose.

    - Beta cell membranes contain both calcium ion channels and potassium ion channel
    - Potassium ion channels are open under normal blood glucose concentration.
    - Calcium ion channels are closed under normal blood glucose concentration.
    - Potassium ions diffuse out of the cell, making the inside more negative.
    - The potential difference is -70mV
    - **1** When glucose concentrations outside the cell are high, glucose diffuses into the beta cell.
    - **2** Glucose is quickly metabolised to produce ATP
    - **3** ATP causes the potassium channels to close.
    - Potassium no longer diffuses out of the beta cell

- **4** The potential difference becomes less negative – the cell membrane depolarises.
- **5** The potential difference causes the voltage gated calcium channels to open
- **6** Calcium enters the beta cell and causes the vesicles containing insulin to migrate and fuse with the plasma membrane
- Insulin is released into the blood stream.



Compare and contrast the causes of Type 1 (insulin-dependent) and Type 2 (non-insulin-dependent) diabetes mellitus.

- **Diabetes Mellitus**
  - A disease in whichthe body can no longer control its blood-glucose concentrations
  - Can lead to high blood-glucose concentrations
    - Hyperglycaemia
  - Can lead to low blood-glucose concentrations
    - Hypoglycaemia

- **Type I Diabetes Mellitus – Juvenile Diabetes/Insulin dependent diabetes**
    - Usually starts in childhood
    - It is a genetical disorder and can result from
        - A viral infection
        - An autoimmune response
            - Body's own immune system attacks the beta-cells
    - No insulin is produced
    - Treatment includes
        - Monitoring the blood glucose concentration
        - Insulin injections

- **Type II Diabetes Mellitus – Adult Diabetes/Insulin independent diabetes**
    - Usually starts later in life
    - Insulin is still produced however the responsiveness of receptors decreases
    - It is a lifestyle disorder and risk factors include
        - Increasing age
        - Obesity
        - A diet high in sugars
        - A diet high in fats
        - A sedentary lifestyle
        - A family history (genetics)
        - Ethnicity – Asian / Afro-caribbean
        - Being male
    - Treatment includes
        - Monitoring the blood glucose concentration
        - Monitoring the diet
        - Limit carbohydrate intake
        - IN some cases Insulin injections canhelp

Discuss the use of insulin produced by genetically modified bacteria, and the potential use of stem cells, to treat diabetes mellitus.

- **Benefits of using insulin produced from genetically modified bacteria.**
- cheaper source of insulin / more reliable supply / ref to large scale production;
- more rapid response / shorter duration of response;
- less chance of, immune / allergic, response;
- better for people who have developed a tolerance for animal insulin / less needed;
- acceptable to people who have ethical, moral or religious objections; **A** vegetarians
- no risk of, infection / contamination

Outline the hormonal and nervous mechanisms involved in the control of heart rate in humans.