Reproductive Physiology

Learning Outcomes

1. Understand the relationship between the hypothalamus, anterior pituitary and peripheral glands in regulating hormone release
    a. The role of negative feedback regulation
    b. The role of positive feedback amplification
2. Explain the role of binding proteins in circulation as important mediators in hormone delivery
3. Identify stages of meiosis as they related to both oogenesis and spermatogenesis
4. Describe the hormonal regulation of spermatogenesis
5. Describe the hormonal regulation of oogenesis
6. Recognize and explain the relationship between the ovarian and uterine cycles

Learning Objective 1: Hormonal Regulation

The relationship between the hypothalamus, anterior pituitary, and peripheral glands is crucial for hormone release regulation. This involves:

- **Negative Feedback Regulation:** A self-regulating system where the stimulus activates a reflex that alleviates the stimulus, restoring balance and signaling to switch off the reflex.
- **Positive Feedback Amplification:** The stimulus enhances the reflex, increasing the signal to drive the reflex and amplifying the response.

Positive feedback cycle during childbirth: it begins when the baby's head pushes against the cervix, triggering stretch receptors. These receptors send signals to the brain, which prompts the release of oxytocin from the posterior pituitary gland. Oxytocin increases the strength and frequency of uterine contractions, further pushing the baby down. As the baby moves further through the birth canal, more stretch receptors are activated, leading to more oxytocin release.

The Hypothalamus and Pituitary Gland

The hypothalamus and pituitary gland work together to regulate hormone release:

- **Posterior Pituitary:** Secretes hormones like oxytocin and antidiuretic hormone (ADH)/ vasopressin into circulation, which were synthesised in the hypothalamus.
- **Anterior Pituitary:** Hormones synthesised in the hypothalamus are released into the hypophyseal portal system and control release of hormone release from the anterior pituitary. Hormones synthesised at the AP are released into circulation to control hormone release from other glands in the body (trophic hormones).

Definitions

- **Tropic/Trophic Hormones:** Hormones secreted by the anterior pituitary that stimulate hormone secretion from other glands (alternative name for stimulating hormones – SH)
- **_trophs:** Cells that secrete trophic hormones (anterior pituitary)
- **_statin:** Inhibiting hormones.
- **Releasing Hormones:** Secreted from the median eminence to stimulate anterior pituitary hormone release.

Thyroid Hormone Regulation

Thyroid hormones are regulated through negative feedback mechanisms, ensuring homeostasis in hormone levels. It begins when the hypothalamus releases thyrotropin-releasing hormone (TRH), which stimulates the pituitary gland to release thyroid-stimulating hormone (TSH). TSH then acts on the thyroid gland, prompting it to produce and release thyroid hormones. These hormones regulate metabolism and other bodily functions. As their levels rise, they inhibit the release of TRH and TSH, preventing overproduction.

Learning Objective 2: Binding Proteins in Hormone Delivery

Hormones can be derived from various sources:

- Amino acids (hydrophilic/hydrophobic)
- Protein hormones (hydrophilic)
- Lipid-derived hormones (hydrophobic) e.g. cholesterols and phospholipids

Lipid soluble molecules cannot dissolve in water. Binding proteins in blood, such as albumin and corticosteroid-binding globulin (CBG), play a crucial role in carrying and circulating hydrophobic hormones. Binding proteins regulate the availability of steroid hormones for receptor binding, with only the unbounded state allowing for hormones to exit circulation and enter the target cell.

Binding proteins found in blood:

- Albumin: abundant; low specificity and low affinity; main role = buffer steroid concentration in blood
- Corticosteroid-binding globulin (CBG): low concentration' high specificity and affinity for glucocorticoids and progesterone
- Sex hormone-binding globulin (SHBG): androgens and oestrogen

Binding proteins can also compartmentalise steroid hormones. In the testes, ABP binds to testosterone, maintaining high local concentrations necessary for spermatogenesis within the seminiferous tubules. By binding the hormone, ABP helps prevent its free diffusion and avoids negative feedback of LH from high levels of systemic testosterone.