1. STEROID HORMONES v PEPTIDE HORMONES

These are chemical messengers secreted by endocrine glands directly into the blood

The blood carries them to target cells

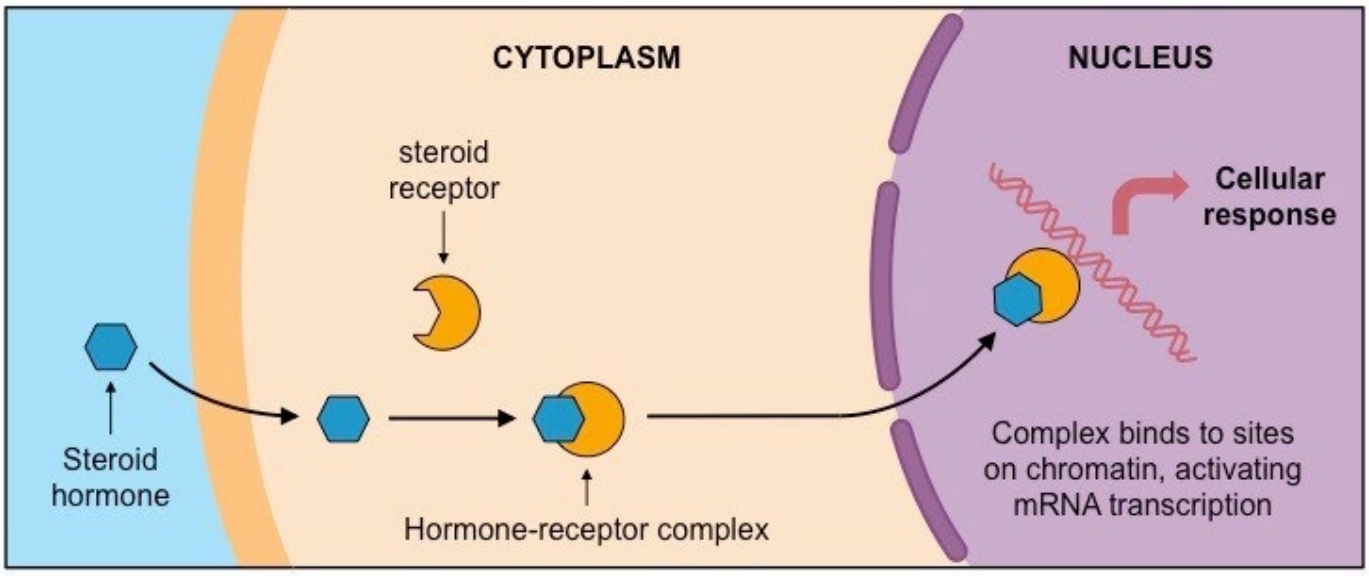
Where they attach to a receptor and cause a response

Most hormones fall into one of two chemical groups:

- **Steroids** e.g. estrogen, progesterone, testosterone.
- **Peptides** (small proteins) e.g. insulin, glucagon, ADH, FSH, leptin, oxytocin.

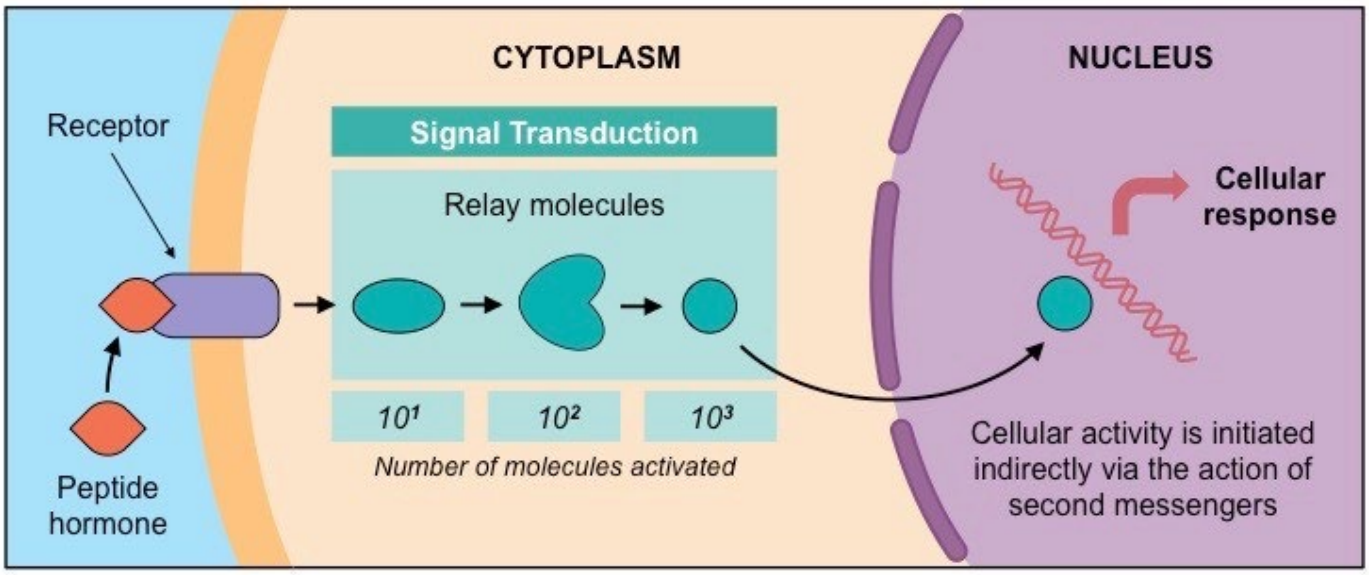
You need to know how these two groups are **different**.

(a) Steroid Hormones



- Are **lipophilic** ('fat-loving').
- (So) they **enter cells** by **diffusing** across the **plasma membrane**.
- (And) **attach** to **receptors** in the **cytoplasm** to form a **hormone-receptor complex**.
- This hormone-receptor complex **moves** into the **nucleus** and **attaches** directly to **DNA**.
- The hormone-receptor complex **controls transcription** of specific genes by **attaching** to the **promote**r.
- It can **stimulate** or **inhibit transcription** of specific genes.
- In this way, they **control** if specific **enzymes** or **other proteins** are made.

(b) Peptide Hormones



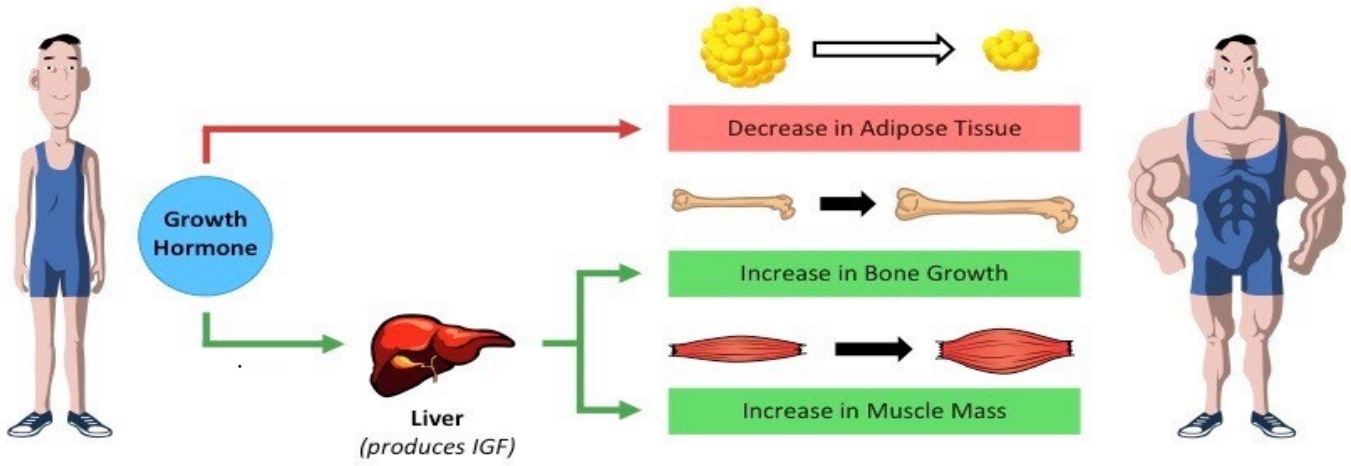
- Peptide hormones are **hydrophilic** and **lipophobic** ('fat-hating') – meaning they **cannot enter** the cell by **diffusing** across the **plasma membrane**.
- They attach to **receptors** in the **plasma membrane**, which are typically joined to internally anchored proteins (e.g. G proteins).
- The hormone-receptor complex **activates** a **series** of intracellular molecules called **second messengers**.
- Secondary messengers **trigger** a **cascade** of **chemical reactions** inside the cell.
- This usually involves **activating** or **inhibiting enzymes**.
- This process is called **signal transduction**, because the **external** signal (hormone) is **transduced** via **internal** intermediates.
- The use of second messengers enables the **amplification** of the **initial** signal (as **more** molecules are **activated**)
- Examples of second messengers include cyclic AMP (**cAMP**), calcium ions (**Ca^{2+}**), nitric oxide (**NO**) and **protein kinases**.
- Peptide hormones require **ATP**.

(c) Compare and contrast steroid hormones and peptide hormones

STEROID HORMONES	PEPTIDE HORMONES
Both **act** on **target cells**	
Both **travel** through the **blood**	
Effects of both **last longer** than effects of **neurotransmitters** (nervous system)	
Enter cell / **diffuse** across **plasma membrane**	Do **not enter cell** / do **not diffuse** across **plasma membrane**
Attach to **receptor** in the **cytoplasm**	**Attach** to **receptor** in **plasma membrane**
Hormone-receptor complex travels to **nucleus**	**Hormone-receptor complex** does **not** travel to **nucleus**
Hormone-receptor complex does **not trigger secondary messengers/cascade** of reactions	**Hormone-receptor complex does trigger secondary messengers/cascade** of reactions
Activate **genes**	Activate **enzymes**
Does not require **ATP**	**Does** require **ATP**
Example given e.g. estrogen	**Example** given e.g. insulin

2. USE OF HUMAN GROWTH HORMONE IN ATHLETICS

- Growth hormone is a **peptide** secreted by the **pituitary gland**.
- It acts **directly** to **decrease** the **formation** of **adipose** (fat) **cells** (i.e. less nutrients stored as fat).
- It acts **indirectly** via causing the **liver** to produce **insulin growth factor** (IGF) – to **increase muscle mass** and **bone size**.



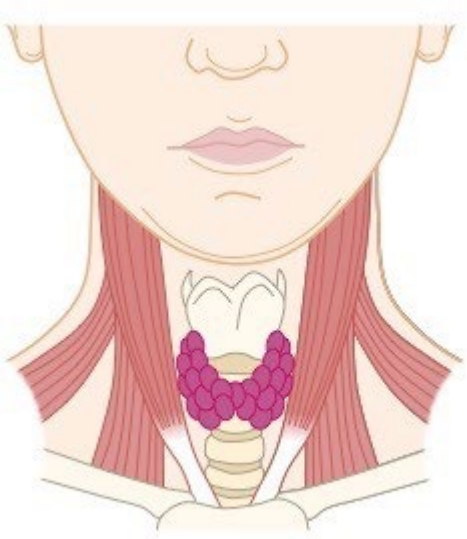
- **Decrease in adipose tissue** – fat is broken down. (**Direct** Effect)
- **Increase in bone growth** – mineralization of bone and proliferation of cartilage cells. (**Indirect** Effect)
- **Increase in muscle mass** – protein synthesis. (**Indirect** Effect)
- Growth hormone stimulates growth of **all organs**, **except** for the **brain**.
- Growth hormone has been used by **athletes** to help **build muscle** and is now **banned**.

A previous difficulty in testing blood for human growth hormone is that we produce it naturally.

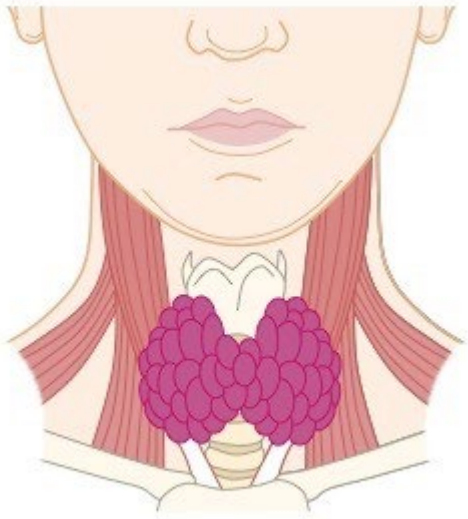
However, blood tests can now distinguish between the natural and artificial versions of human growth hormone and catch illegal users trying to gain an unfair advantage.

3. IODINE DEFICIENCY DISORDER

- **Iodine** is needed for production of the hormone **thyroxin** by the **thyroid gland**.
- A symptom of **iodine deficiency disorder** (IDD) is **swelling of the neck**, called **goitre**.
- This is due to an **enlarged** (swollen) **thyroid gland**.



Normal Thyroid



Goitre

- **Thyroxin** is needed to control two things: **basal metabolic rate (BMR)** and **body temperature**.
- If women are affected **during pregnancy**, their **children** can be born with **permanent brain damage**.
- If children suffer from IDD after birth, their **mental development** and **intelligence** are **impaired**. **Cretinism** is a severe form of this.
- Iodine deficiency is **common** in many countries, as iodine is **not** a **common** component of **most** diets (except for sea food diets).
- The **International Council for the Control of Iodine Deficiency Disorders** works to eliminate the harm of iodine deficiency.
- One strategy employed is to **add iodine** to **common** dietary products (e.g. **iodised table salt**).

4. CONTROL OF MILK SECRETION

- The **production** and **secretion** of **milk** by **mammary glands** following birth is called **lactation**.
- It is mainly controlled by two key hormones – **prolactin** and **oxytocin**, which are secreted by the **pituitary gland**.

PROLACTIN

Stimulates mammary glands to grow

Stimulates the production of milk

Secreted by the **anterior** pituitary gland

During pregnancy, **high** levels of **oestrogen** **increase** prolactin production

However, **high** levels of **progesterone** **inhibit** the **effects** of prolactin

This prevents milk production from happening **before** birth

Progesterone level **falls** soon **after** birth, **allowing** milk to be **produced**

The milk is stored in **small spherical chambers** (**alveoli**) throughout the **mammary gland**

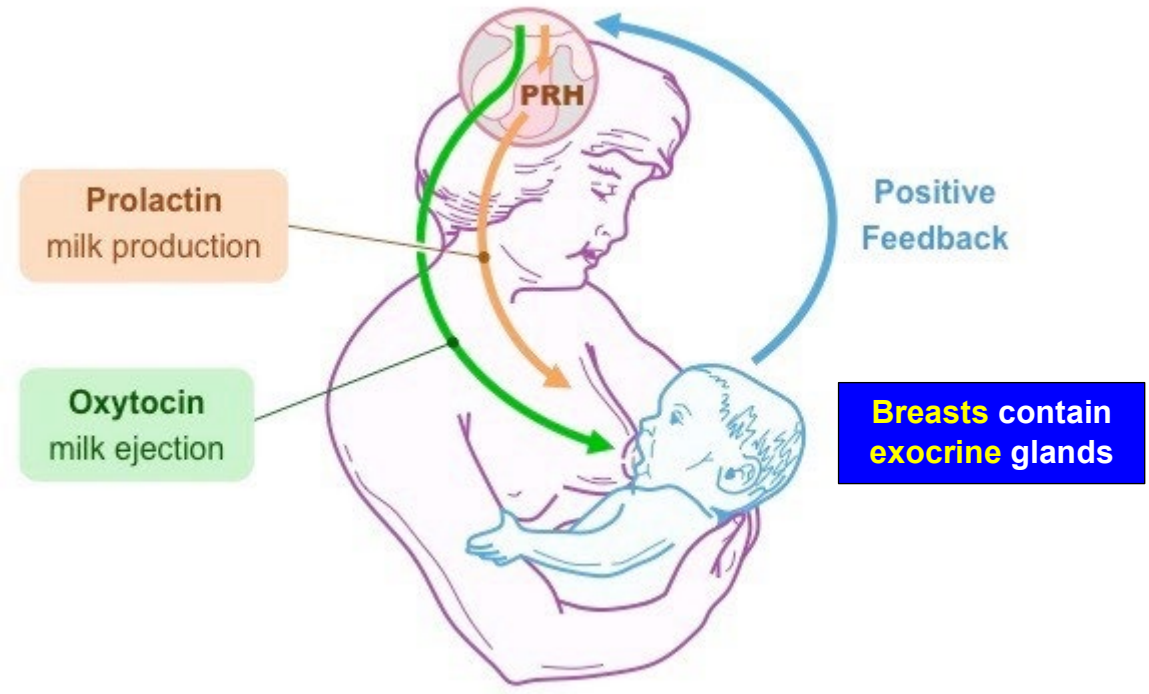
OXYTOCIN

Stimulates the release of milk

Secreted by the **posterior** pituitary gland

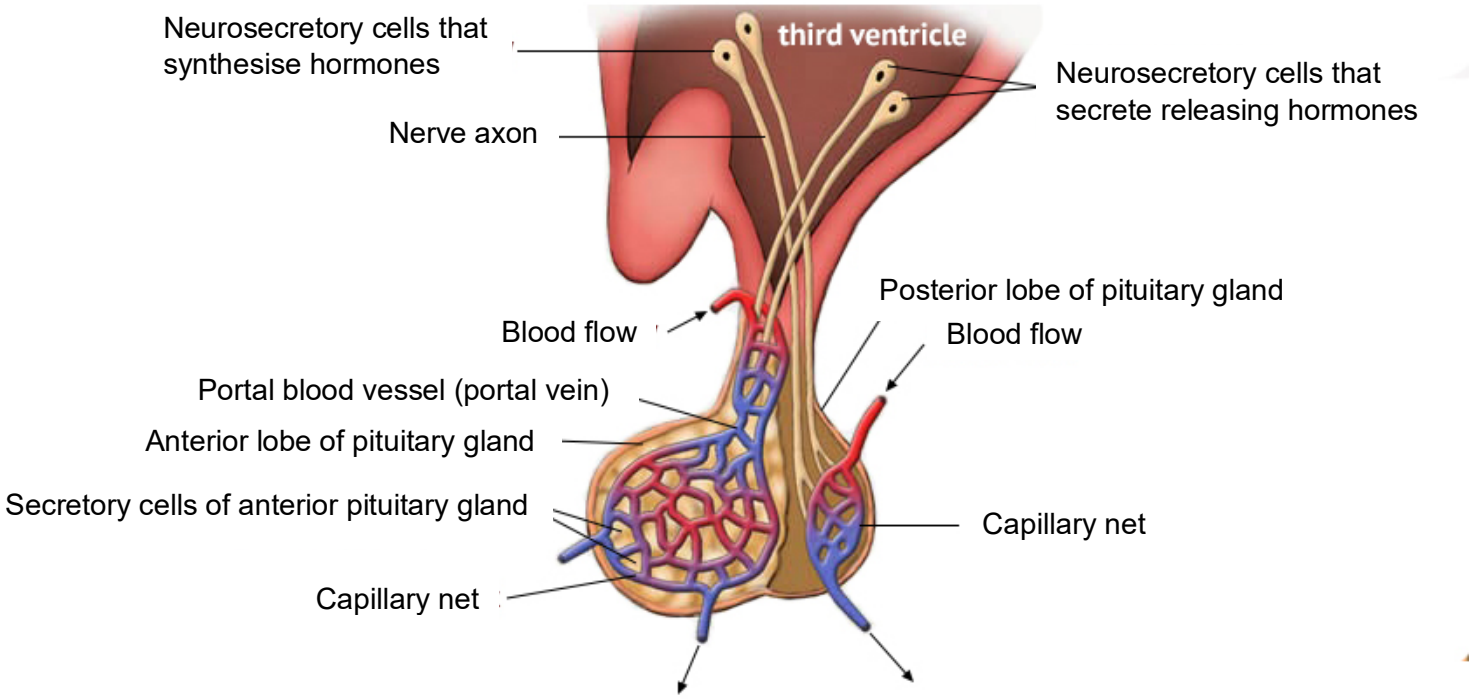
Oxytocin release is **triggered** by stimulation of **sensory receptors** in **breast** tissue by the **suckling infant**

This creates a **positive feedback loop** that will result in **continuous oxytocin secretion** until the **infant stops feeding**



5. HORMONES AND THE HYPOTHALAMUS

- The **hypothalamus** is a part of the brain that **links** the **nervous** and **hormonal** systems.
- It receives **impulses** from **nerves** throughout the body and **other parts** of the **brain**.
- It **controls** hormone **secretion** of the **pituitary gland**, located **below** it.
- The pituitary gland has **two** lobes: **anterior** (frontal) and **posterior** (at the back).



How the hypothalamus controls the anterior pituitary gland

- Some **neurosecretory** cells in the hypothalamus **secrete releasing hormones** into **capillaries**.
- These capillaries **join** to form a **portal blood vessel** (bridge) that connects to **capillaries** in the **anterior lobe** of the pituitary gland.
- These **releasing hormones** trigger **secretion** of hormones **made** by the **anterior pituitary gland**.
- **FSH** and **prolactin** are released in this way.

How the hypothalamus controls the posterior pituitary gland

- Some **neurosecretory** cells in the hypothalamus **synthesise hormones** and **pass them** by **nerve axons** (tails) for **storage** by **nerve endings** in the **posterior pituitary gland**.
- The subsequent **secretion** of these hormones by the **posterior pituitary gland** is **controlled** by the **hypothalamus**.
- **ADH** and **oxytocin** are released in this way.