SAWA UNIVERSITY

Clinical Endocrinology

Pituitary Anterior Gland

Sawa University

College of health and medical techniques

Department of Medical Laboratories

.Third . Stage

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كليـــــة التقنيـــات الصحيـة والطبيـة

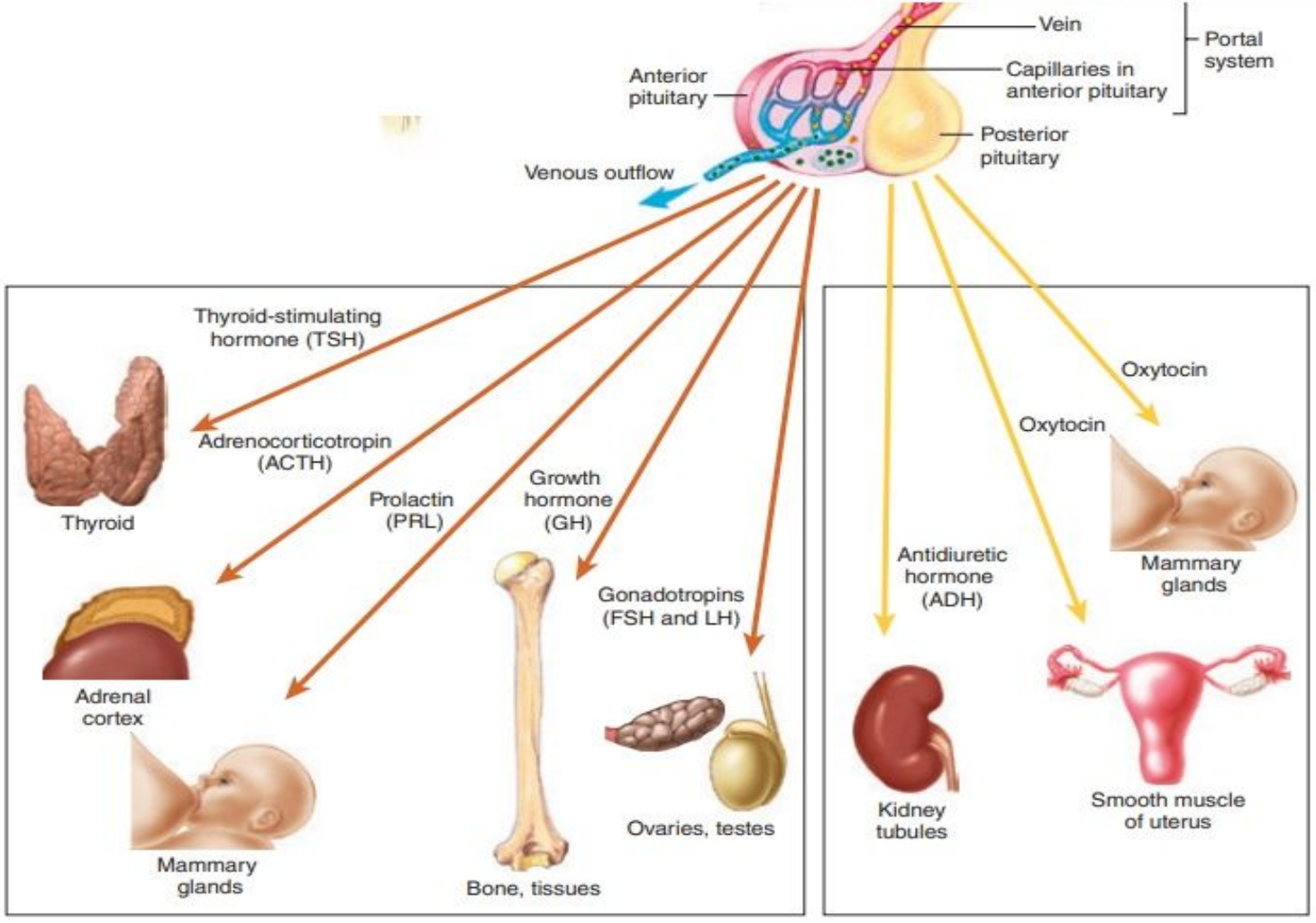
قسم تقنيات المختبرات الطبية

المرحلـــــــــــــة الثالـثة

تدريسي المادة : م.م عقيل محمد رسول

الجانب النظري Theoretical

محاضرة رقم 5 Lecture No. 5



The pituitary gland.

The hormones secreted by the **anterior lobe of the pituitary gland** are:

A. **Growth hormone**
B. **Pituitary tropic hormones**

A) Growth Hormone (Somatotropin)

- The growth hormone (or somatotropin) is **produced by** **somatotropin**, **a special group of acidophilic cells** of anterior pituitary.
- ***Regulation of GH release***: ***Two hypothalamic factors play a prominent role*** in the release of growth hormones. ***These are***
  - the growth hormone releasing hormone (**GRH**) **that stimulates**
  - the growth hormone release-inhibiting hormone (**GRIH, somatostatin**) **that inhibits**.
- This, in turn, ***is regulated by*** **a feedback mechanism**.
- Growth hormone ***production is influenced by*** many factors such as ***sleep, stress (pain, cold, surgery), exercise, food intake etc.***
- ***It is observed*** that the **largest increase** in the **production of GH occurs after the onset of sleep**. This supports the adage "If you don't sleep, you won't grow.

Biochemical functions of GH: Growth hormone promotes growth, and also influences the normal metabolisms (protein, carbohydrate, lipid and mineral) in the body.

1. **Effects on growth**: As is obvious from the name, **GH is essential for the growth**. The growth-related effects of GH are mediated through **insulin like growth factor I (IGF-I)** which **is also known as somatomedin C** (formerly **sulfation factor**), **produced *by liver***.

2. Effects on protein metabolism: Growth hormone has **an anabolic effect** on protein metabolism. *It promotes the uptake of amino acids into the tissues and increases the protein synthesis*. **The overall effect of GH is a positive nitrogen balance** that **leads to increase in body weight.**

3. Effects on carbohydrate metabolism: Growth hormone is **antagonistic to insulin and causes hyperglycemia. *GH increases gluconeogenesis, decreases glucose utilization*, impairs glycolysis and reduces the tissue uptake of glucose**.

4. Effects on lipid metabolism: Growth hormone promotes **lipolysis in the adipose tissue** and **increases the circulatory levels of free fatty acids and their oxidation**. ***It increases ketogenesis, particularly in diabetes.***

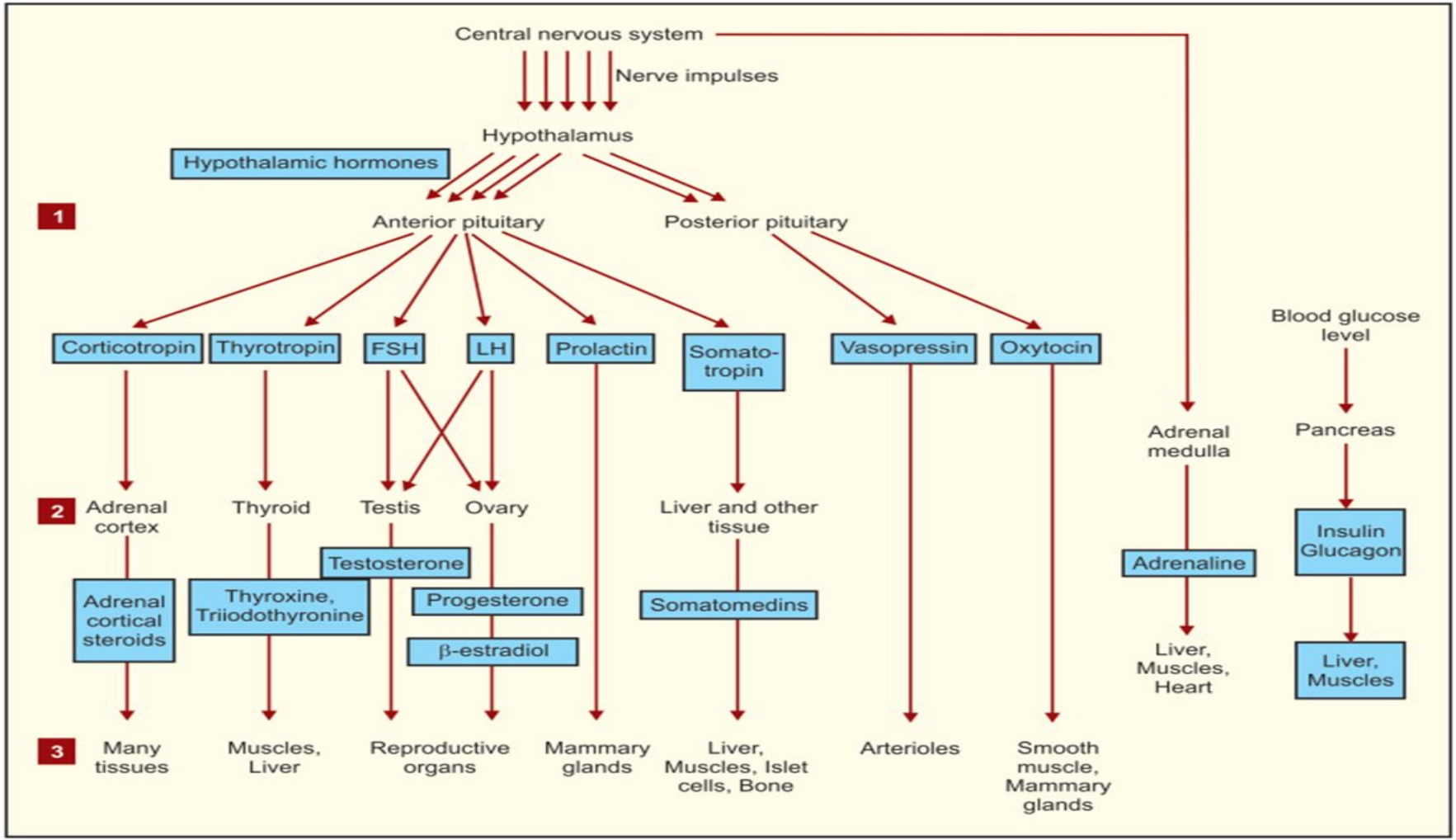


Fig. 23.1: Schematic master plan of the regulatory relationship between the endocrine glands and their ultimate target tissue.
1: First target tissue; 2: Second target tissue; 3: Third target tissue.

Abnormalities of GH production

Deficiency of GH: Impairment in the secretion of growth hormone **in the growing age** causes **dwarfism.**The *other deficiency metabolic effects* are not that serious in nature.

Overproduction of GH: Excessive production of GH causes **gigantism in children and acromegaly in adults**. This **usually occurs** in the **acidophil tumor of pituitary gland**. **Gigantism** is **characterized by** *increased growth of long bones* and this is observed **before the epiphyseal plates close**.

Acromegaly occurs **after epiphyseal closure** and is **characterized by** *increase in the size of hands, facial changes (enlarged nose, protruding jaw), excessive hair, thickening of skin etc.*

B) Pituitary tropic Hormones

In addition to GH, anterior pituitary gland secretes some tropic hormones usually called ***as pituitary tropins***.

What are “tropins”?

- **A tropin or tropic hormone** is the one which **influences the activities of other endocrine gland**, **principally** those **involved in stress and reproduction**.
- These **are carried by** the blood **to another target gland**. **The pituitary tropins** are **under the positive and negative control** of **peptide factors from hypothalamus**.
- Further the **tropic hormones** are usually subject **to feedback inhibition** at the pituitary or hypothalamic level by hormone product of the final target gland.
- Prolactin (mammotropin), TSH (or thyrotropin), FSH and LH (gonadotropins), ACTH (corticotropin) are the tropic hormones secreted by the pituitary gland

1. Prolactin: PRL or Leuteotropic Hormone (LTH)

It is **secreted by lactotroph α-cells** of anterior pituitary and as already mentioned has ***sequence homology with growth hormone***.

Metabolic role

- **The main function of PRL** is to **stimulate mammary growth** and **the secretion of milk**. **By acting through** *specific glycoprotein receptors* on plasma membrane of mammary gland cells, **it stimulates mRNA synthesis**. This ultimately **leads to enlargement of breasts during pregnancy**. This is called **as mammotropic action**.
- The *synthesis of milk proteins* such as ***lactalbumin, and casein*** takes place after parturition such an effect is called as **lactogenic action**.
- ***Estrogens, thyroid hormones and glucocorticoids*** **increase the number of prolactin receptors** on the mammary cell membrane.

2- Thyrotropic Hormone or Thyroid Stimulating Hormone (TSH)

This is **produced by basophil cells** of anterior pituitary and is *glycoprotein in nature*. This consists of ***α and β subunits***.

Note: The ***α-subunit of TSH, LH, HCG and FSH*** **are nearly identical**.

Metabolic role

There are *receptors on the thyroid cell membrane* which bind to the receptor **binding site on β-subunit of TSH**. The complex then **activates adenylate cyclase** which **catalyses** the **formation of c-AMP which acts as the second messenger** for **most TSH actions as follows:**

- The **TSH stimulates** the **synthesis of thyroid hormones at all stages** such as ***Iodine uptake, organification and coupling.***
- It enhances the **release of stored thyroid hormones.**
- It increases DNA content, RNA and translation of proteins, cell size.
- It **stimulates glycolysis, TCA cycle**, **HMP and phospholipid synthesis**. **Stimulation of last two does not involve c-AMP.**
- **It activates adipose tissue lipase to enhance the release of fatty acids (lipolysis).**

3. Adrenocorticotropic Hormone (ACTH) or Corticotropin.

Two forms have been isolated, **α-corticotropin and β-corticotropin.**

ACTH is synthesized as *a part of precursor peptide*. The precursor molecule is synthesized as a glycoprotein called **Proopiomelanocortin peptide** (**POMC**). ***Various proteolytic enzyme*** *hydrolyses POMC to give* ***different peptides***. Thus, **POMC is broken down** into **ACTH, β-lipotropin (LPH). β-LPH is further cleaved into γ-LPH and endorphins**.

Metabolic role

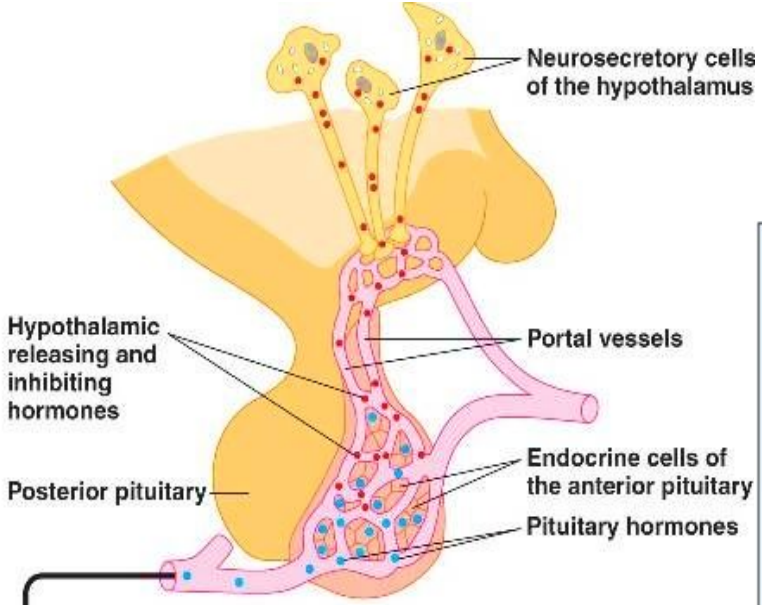
- The **principal actions** of corticotropin **are exerted** on the adrenal cortex and extraadrenal tissue**. ACTH increases** the synthesis of corticosteroids **by the adrenal cortex** and also **stimulates their release from the gland**. Profound changesin the *adrenal structure, chemical composition and enzymatic activity are* **observed as a response to ACTH**. Total protein synthesis is found to be increased.

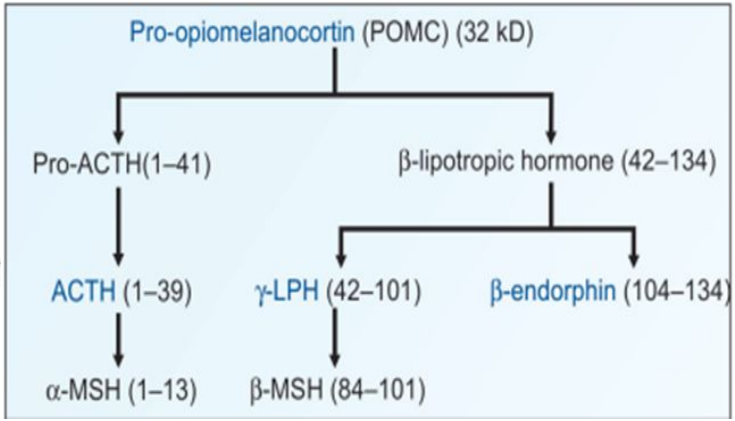
1. ACTH also ***stimulates the synthesis and secretion of glucocorticoids***.
2. ACTH is found **to increase the transfer** of cholesterol from plasma lipoproteins into the fasciculate cells.
3. ACTH **induces rise** in c-AMP, brings about phosphorylation and activation of cholesterol esterase.
4. **cholesterol esterase** is enzyme action ultimately makes **a large pool of free cholesterol**.
5. Corticotropin *promotes the binding of cholesterol* to mitochondrial cytochrome P450 required for hydroxylating cholesterol.
6. It **activates the rate limiting** enzyme for *conversion of cholesterol to* ***pregnenolone*****.**
7. It activates dehydrogenases of hexose monophosphate pathway (**HMP**) to *increase the conc. of NADPH* required for hydroxylation.
8. **By activating adenylate cyclase** of adipose tissue it increases intracellular c-AMP which in turn activates hormone sensitive lipase. This enzyme is involved in lipolysis which increases the level of free fatty acids.
9. It **leads to** increased ketogenesis and decreased Respiratory Quotient (**RQ**).
10. Direct **effects on carbohydrate metabolism** include:
    - Lowering of blood glucose ↓;
    - Increase in glucose tolerance;
    - **Deposition of glycogen** ترسب in adipose tissue **is increased**, regarded as due to *stimulation of insulin secretion.*
    - It has **MSH activity** due to homology in amino acid seq

Tropic effects only:
FSH
LH
TSH
ACTH

Nontropic effects only:
Prolactin
MSH

Nontropic and tropic effects:
GH





HORMONE	FSH and LH	TSH	ACTH	Prolactin	MSH	GH
TARGET	Testes or ovaries	Thyroid	Adrenal cortex	Mammary glands	Melanocytes	Liver, bones, other tissues

4. Pituitary Gonadotropins

These tropic hormones **influence** the **function and maturation** of **the testes and ovary** and two types:

- **Follicle Stimulating Hormone (FSH)**
- **Luteinizing Hormone (LH)**

 Both of them are glycoproteins with sialic acid. As already mentioned, **FSH and LH are dimers** of **α and β-chains** linked noncovalently. The **α-chain is identical** for TSH, FSH and LH of the same species.

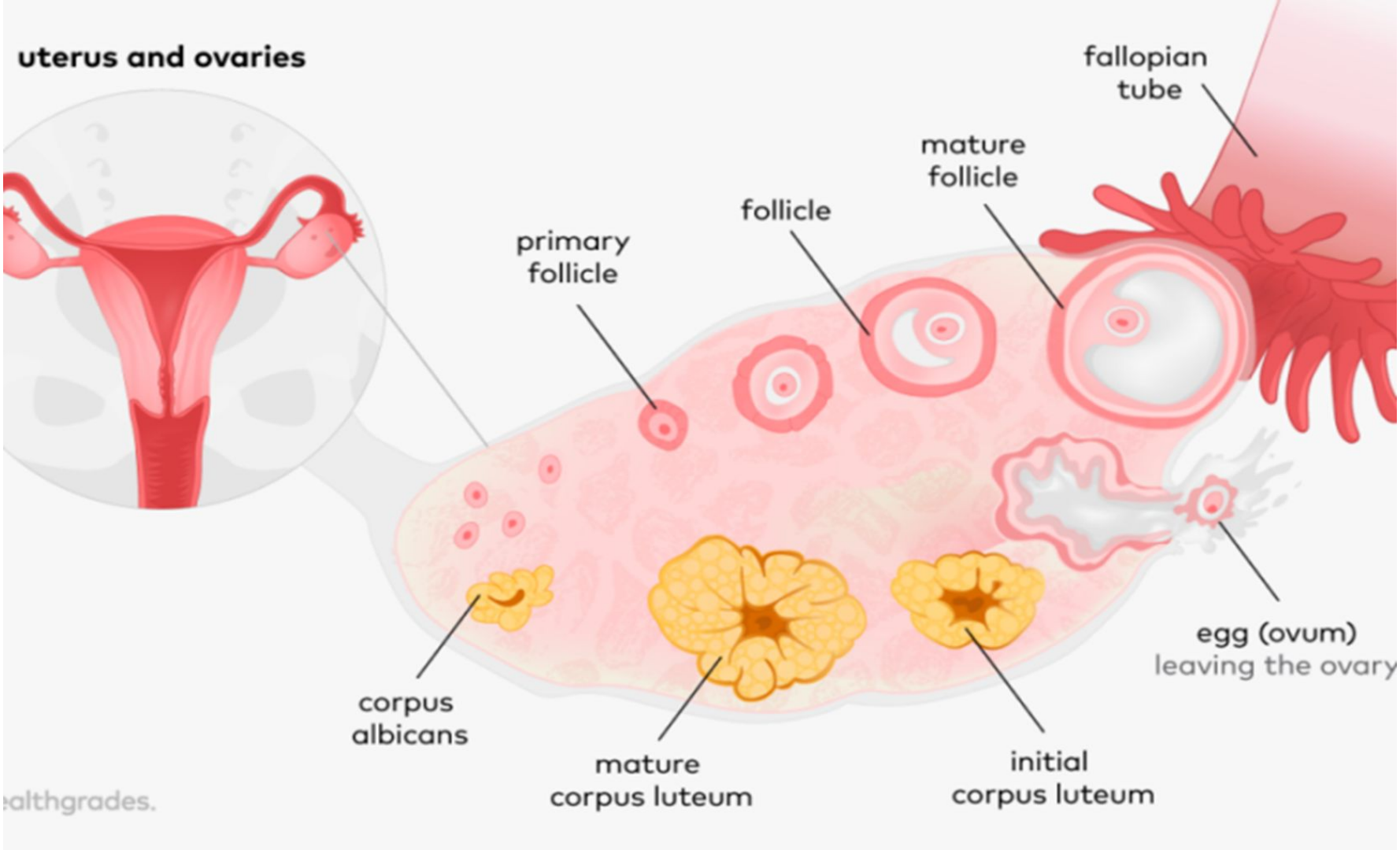
Metabolic Role of FSH

 It brings about its action by specific receptor binding and c-AMP.

Role of FSH in Spermatogenesis

 The conversion *of primary spermatocytes into secondary spermatocytes* in **the seminiferous tubules** is **stimulated by FSH**. In **absence of FSH**, spermatogenesis **cannot proceed**. **However**, **FSH by itself** cannot cause complete formation of spermatozoa. For its completion, **testosterone is also required**.

 Thus, **FSH seems** to initiate the proliferation process of spermatogenesis, and **testosterone is apparently necessary for final maturation of spermatozoa**. Since the **testosterone is secreted under the influence of LH.**


uterus and ovaries
fallopian tube
mature follicle
follicle
primary follicle
egg (ovum) leaving the ovary
corpus albicans
mature corpus luteum
initial corpus luteum
ealthgrades.

Metabolic Role of LH

This hormone is also **known as** interstitial cells stimulating hormone (**ICSH**).

Action of LH in Ovulation: **Ovulatory surge for LH** It is **necessary for** final follicular growth and ovulation. **Without this hormone**, even though **large quantities of FSH are available**, *the follicle will not progress to the stage of ovulation*.

LH acts synergistically with FSH to cause rapid swelling of the follicle shortly before ovulation.

It is worth noting that **especially large amount of LH called ovulatory surge** is secreted by the pituitary **during the day** immediately **preceding ovulation**. *Regulation of Testosterone Secretion by LH* ,**Testosterone is produced by *the interstitial cells of Leydig only*** when the testes are **stimulated by LH** from the pituitary gland, and the *quantity of testosterone secreted varies approximately in proportion to the amount of LH available*. Thus, in males, *LH stimulates the development and functional activity of Leydig cells (interstitial) and consequently testicular androgen*.

:Questions

?Which hormone stimulates the adrenal cortex to produce corticosteroids.1

?Which of the following is not a gonadotropin .2

?What is the role of FSH in males .3

Learning Resources for Hormone Mechanisms

Here are excellent sources to deepen your understanding of this topic:

Medical Textbooks:

"Harper's Illustrated Biochemistry" (Chapter on Hormones & Signal Transduction): Provides a detailed, yet clear, biochemical perspective on second messenger systems.

"Guyton and Hall Textbook of Medical Physiology" (Chapter 74: Introduction to Endocrinology): Excellent for understanding the physiological principles of hormone-receptor interactions and signaling.

"Greenspan's Basic & Clinical Endocrinology": A comprehensive resource that links basic mechanisms to clinical practice.

YouTube Channels:

Armando Hasudungan: His detailed drawings are fantastic for visualizing signal transduction pathways.

Dr. Najeeb Lectures: Provides extremely detailed lectures on the entire process.