Introduction to Endocrinology

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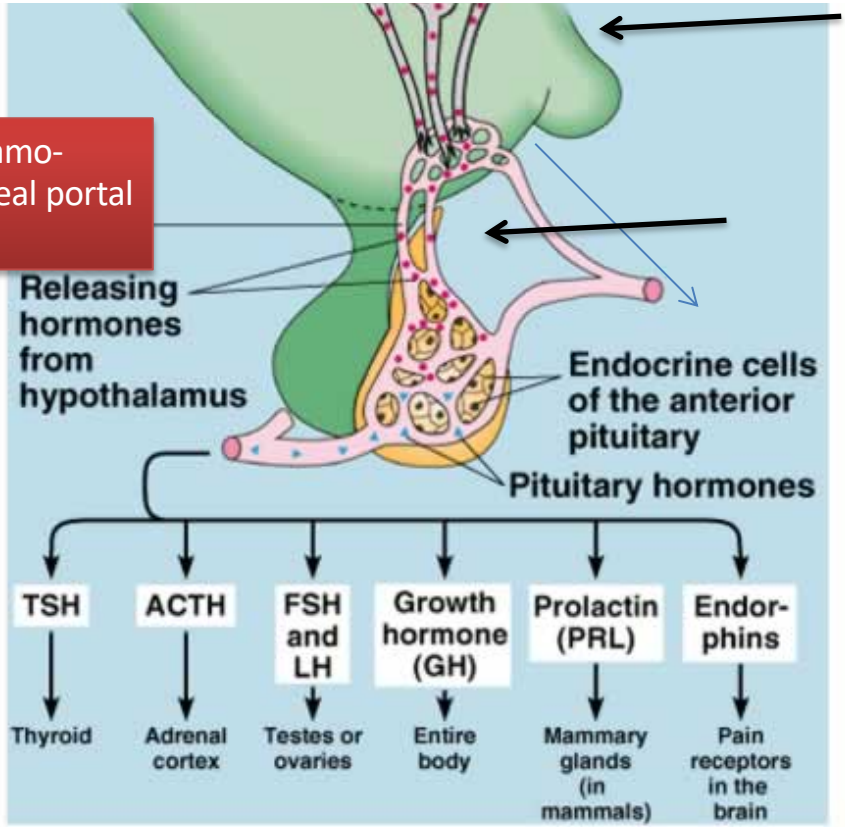
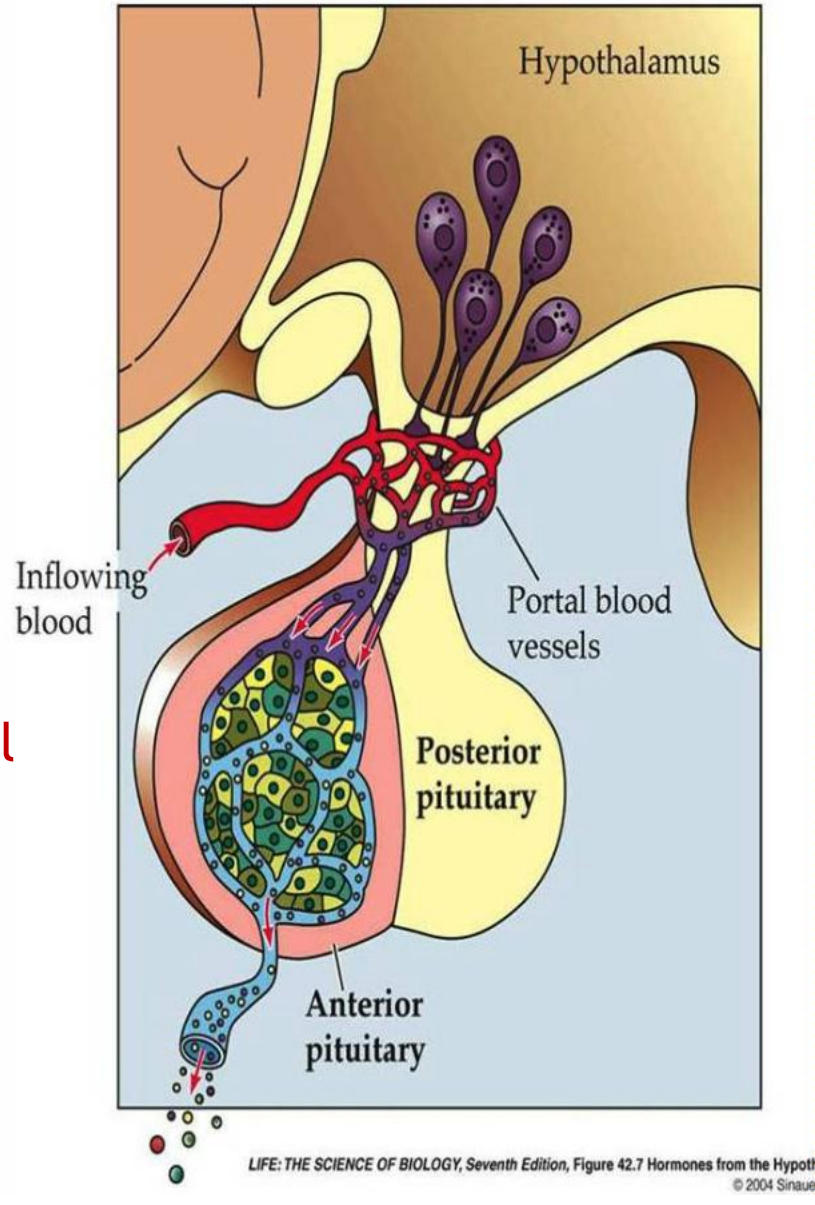
Pituitary gland
Anterior Pituitary = adenohypophysis



Anterior Pituitary
Adenohypophysis

Anterior pituitary gland is connected to hypothalamus by portal system: "hypothalamic-hypophysial portal vessels".



PITUITARY GLANDS

- Anterior pituitary hormones

  Growth Hormone (GH)

  - Physiological functions.

  - Regulation of GH secretion.

    Feedback mechanism

    Factors controlling secretion.

- **Prolactin**

  - Physiological functions

  - Regulation of prolactin secretion.

Growth Hormone - GH

[Somatotropin]

Growth hormone (GH) (somatotrophin)

• In childhood & adolescence regulates **growth** & **metabolism**.

•In adults regulates **energy metabolism**.

Actions:

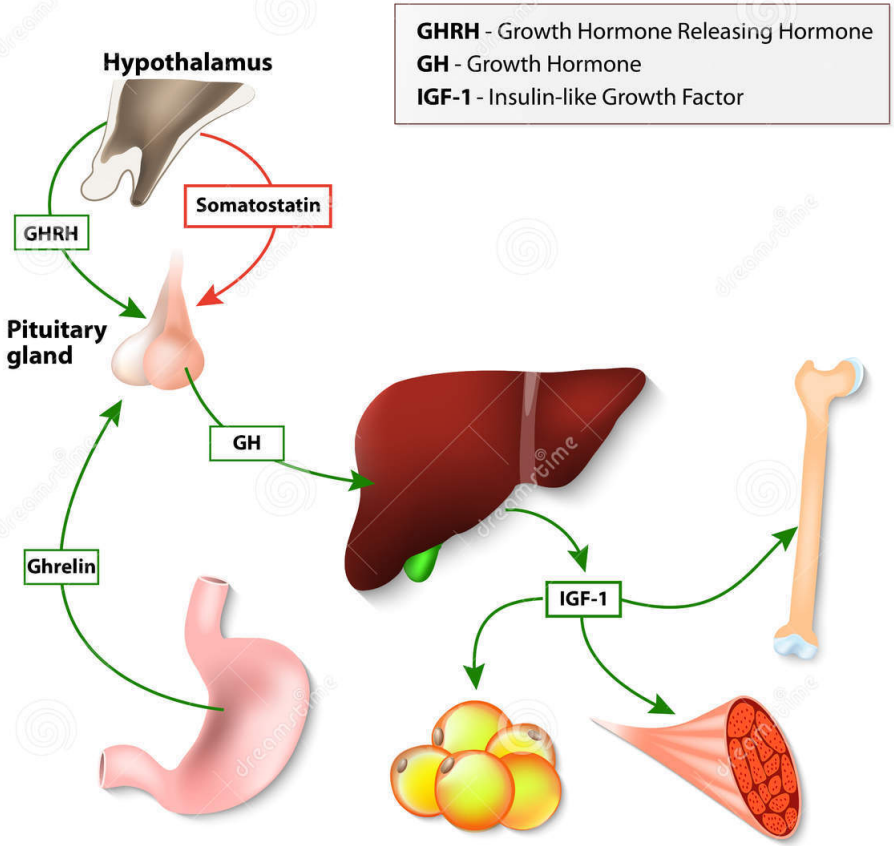
The effect on **growth** is mediated through:

[**Insulin-like growth factor – IGF-1]/ [somatomedian C]**,

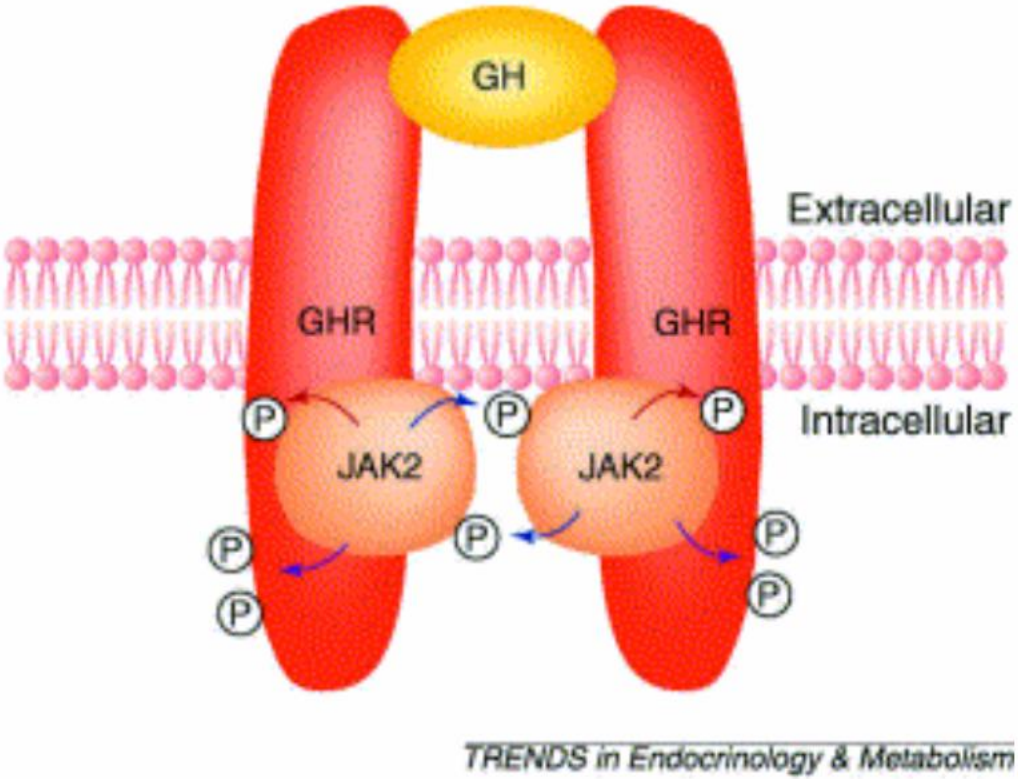
which is secreted by the liver.

• Growth stops with the closure of the epiphysis.

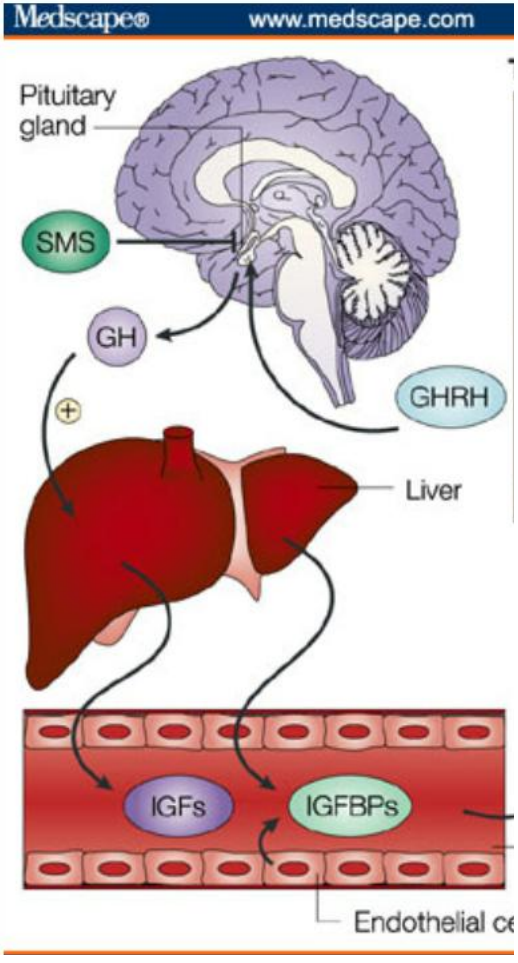
GROWTH HORMONE



Mechanism of Action
Direct Effect

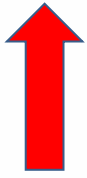


Indirect Effect
SOMATOMEDINS



FUNCTIONS OF GROWTH HORMONE:

A) Long term effect Promotion of growth:

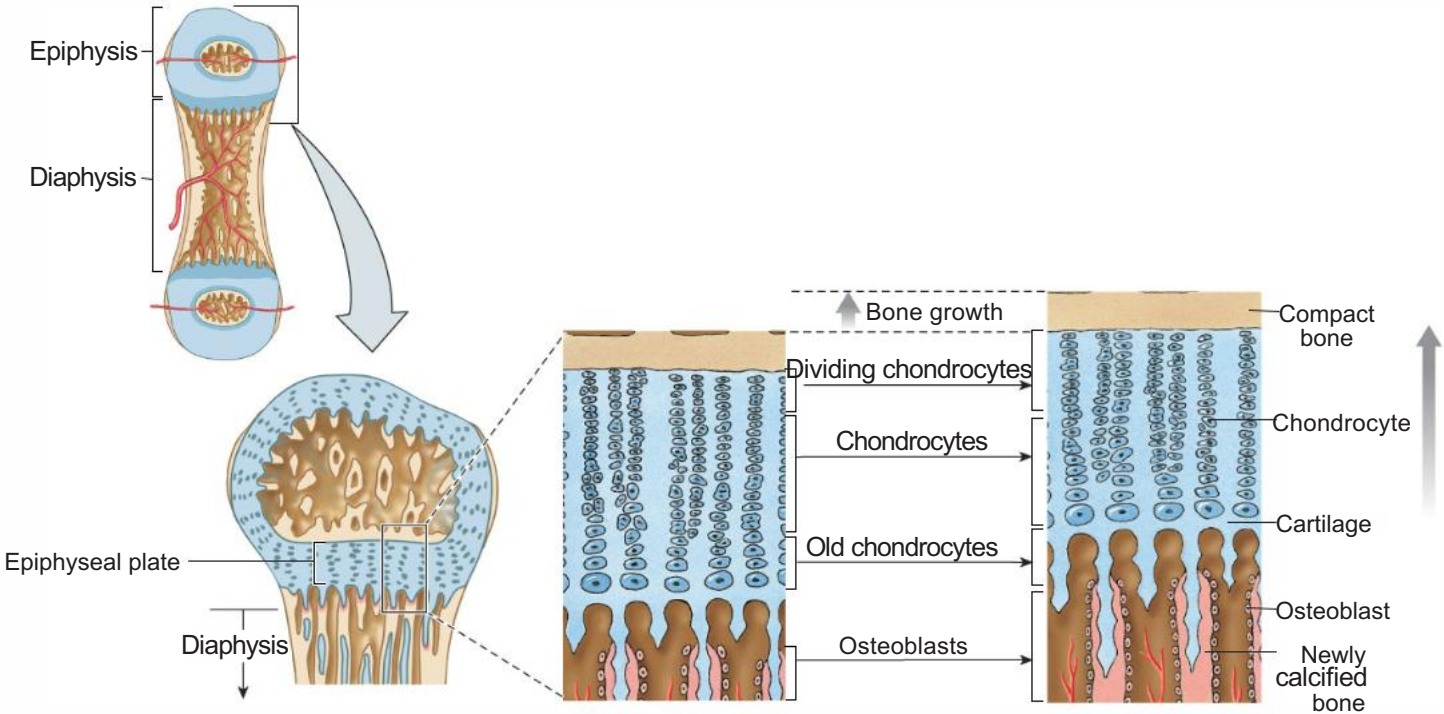


cellular sizes & mitosis
tissue growth & organ size

Indirect effect

Depends on somatomedin C "*insulin– like growth factor*" *[IGF-I&II]* secreted by the liver, which is responsible for effect of GH on bone & cartilage growth & increase the synthesis of protein in skeletal muscles.

BONE GROWTH


Epiphysis
Diaphysis
Epiphyseal plate
Diaphysis
Bone growth
Dividing chondrocytes
Chondrocytes
Old chondrocytes
Osteoblasts
Compact bone
Chondrocyte
Cartilage
Osteoblast
Newly calcified bone

MECHANISMS OF BONE GROWTH

1. Linear growth of long bones:

- When bony fusion occurs between shaft & epiphysis at each end, no further lengthening of long bone occur.

2. Deposition of New Bone (cell proliferation) on surfaces of older bone & in some bone cavities, ? thickness of bone.

- Occurs in membranous bones, e.g. jaw & skull bones.

FUNCTIONS OF GH:

B. Short term Metabolic effects:

↑ Protein metabolism (Anabolic).

Increase rate of protein synthesis in all cells through:

- ↑ amino acids transport into cells.
- ↑ DNA transcription= RNA synthesis.
- ↑ RNA translation= protein synthesis.
- ↓Protein catabolism “protein sparer”.

FUNCTIONS OF GH:

- Fat metabolism: Catabolic

  - Stimulate mobilization of FFAs from adipose tissue stores.

  - Conversion of FFT to acetyl CoA to provide energy.

FUNCTIONS OF GH:

- CHO metabolism: Hyperglycemic

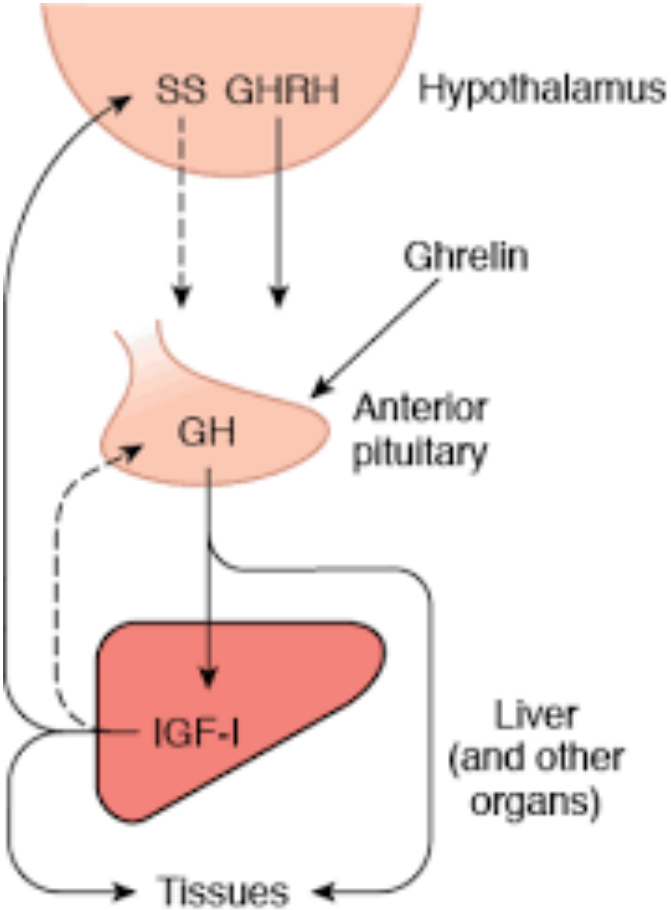
↓ Glucose uptake by tissues (skeletal muscles & fat).

↑ Glucose production by the liver (gluconeogenesis)

Insulin resistance (Diabetogenic)

❖ OTHER EFFECTS OF GH:

- Increases calcium absorption from GIT.
- Strengthens & increases the mineralization of bone.
- Retention of Na+ and K+.
- Increases muscle mass.
- Stimulates the growth of all internal organs excluding the brain.
- Stimulates the immune system.



Source: Barrett KE, Barman SM, Boitano S, Brooks HL: *Ganong's Review of Medical Physiology*: www.accessmedicine.com

CONTROL OF GH SECRETION:

1. The hypothalamus:
   a. GHRH ↑ GH secretion.
   b. GHIH (somatostatin) ↓ GH secretion.

2. Hypoglycemia (fasting) ↑ GH secretion.
   (high glucose intake GH secretion ↓).

3. Muscular exercise ↑ GH secretion.

4. Intake of protein/amino acids ↑ GH secretion (after meals).

CONTROL OF GH SECRETION:

5. During sleep ↑ GH more in children.

6. Stress conditions, e.g. trauma or emotions ↑ GH secretion.

7. FFAs ↓ GH secretion

8. Ghrelin (stomach) ↑ GH secretion.

Table 76-3 Factors That Stimulate or Inhibit Secretion of GH

Stimulate Growth Hormone Secretion	Inhibit Growth Hormone Secretion
- Decreased blood glucose level - Decreased blood free fatty acid levels - Increased blood amino acid levels (arginine) - Starvation or fasting, protein deficiency - Trauma, stress, excitement - Exercise - Testosterone, estrogen - Deep sleep (stages 2 and 4) - Growth hormone–releasing hormone - Ghrelin	- Increased blood glucose level - Increased blood free fatty acid levels - Aging - Obesity - Growth hormone inhibitory hormone (somatostatin) - Growth hormone (exogenous) Insulin-like growth factors (somatomedins)

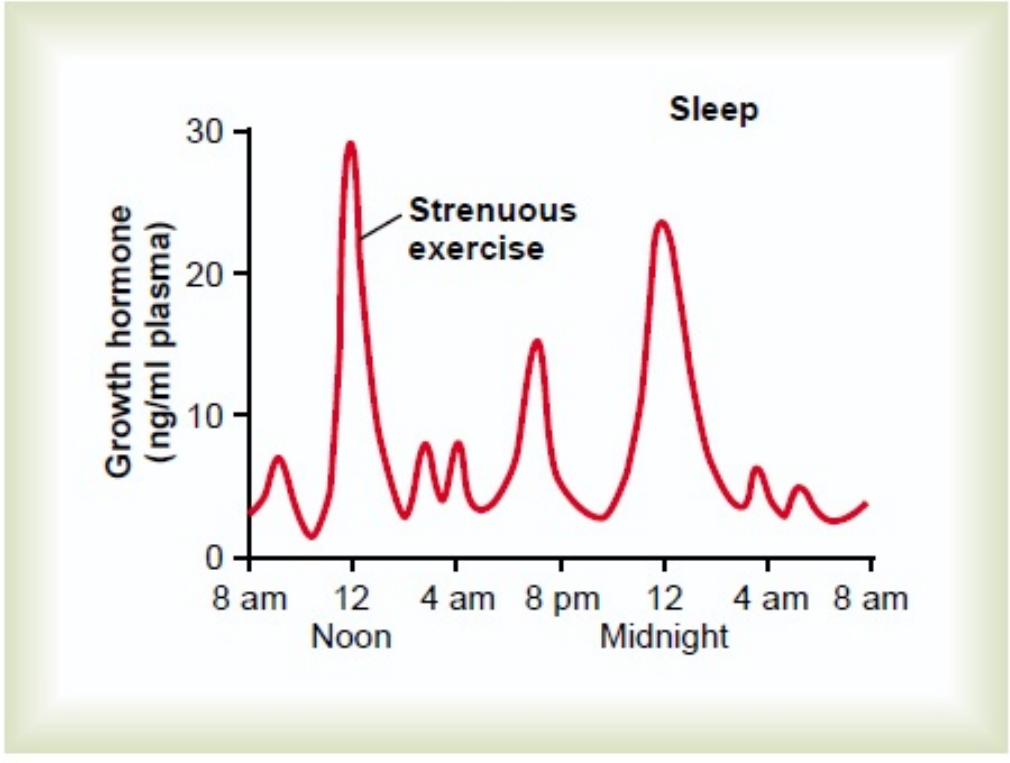


Figure 75–6

Typical variations in growth hormone secretion throughout the day, demonstrating the especially powerful effect of strenuous exercise and also the high rate of growth hormone secretion that occurs during the first few hours of deep sleep.

ABNORMALITIES OF GH SECRETION GH SECRETION:

- Childhood:
- Signs & Symptoms (Gigantism),
  - Increased Height as it occurs before epiphyseal fusion of long bones with their shafts.
  - Hyperglycemia (diabetes).

- Adults:
- Signs & Symptoms

Acromegally,

- soft tissue continue to grow in thickness (skin, tongue, liver, kidney, …)
- Enlargement of bones of hands & feet.
- Enlargement of membranous bones including cranium, nose, forehead bones, supraorbital ridges, vertebrae.
  - Protrusion of lower jaw (?)
  - Hunched back (kyphosis) (enlargement of vertebrae).
  - Hyperglycemia (diabetes).

Gigantism.

• the acidophilic, growth hormone-producing cells of the anterior pituitary gland become excessively active.

• All body tissues grow rapidly, including the bones.

• If the condition occurs before adolescence, height increases so that the person becomes a giant-up to 8 feet tall.

?GH IN CHILDREN

Acromegaly.

Acidophilic tumor occurs after adolescence (after closure of the epiphyses of long bones) i.e. the person cannot grow taller, but the bones can become thicker and the soft tissues can continue to grow.

1- Enlargement is marked in the bones of
- hands & feet
- *membranous bones (*cranium, nose, bosses on the forehead, supraorbital ridges, lower jawbone, & vertebrae)

*Consequently, the lower jaw protrudes forward, sometimes as much as half an inch.

2- Tissue organs (tongue, liver, and kidneys) become greatly enlarged.

Abnormalities of GH secretion

Dwarfism.

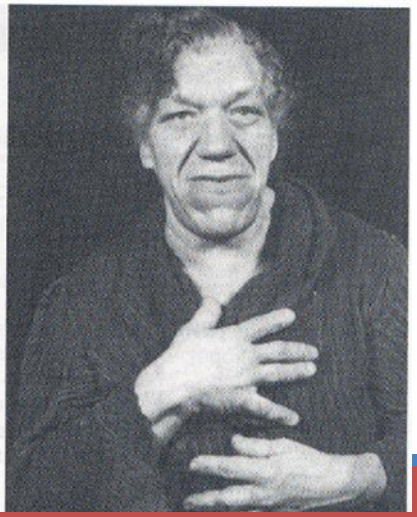
• Usually results from generalized deficiency of ***anterior pituitary*** secretion (panhypopituitarism) during childhood.

• Body parts develop in appropriate **proportion** to one another, but the rate of development is **decreased**.

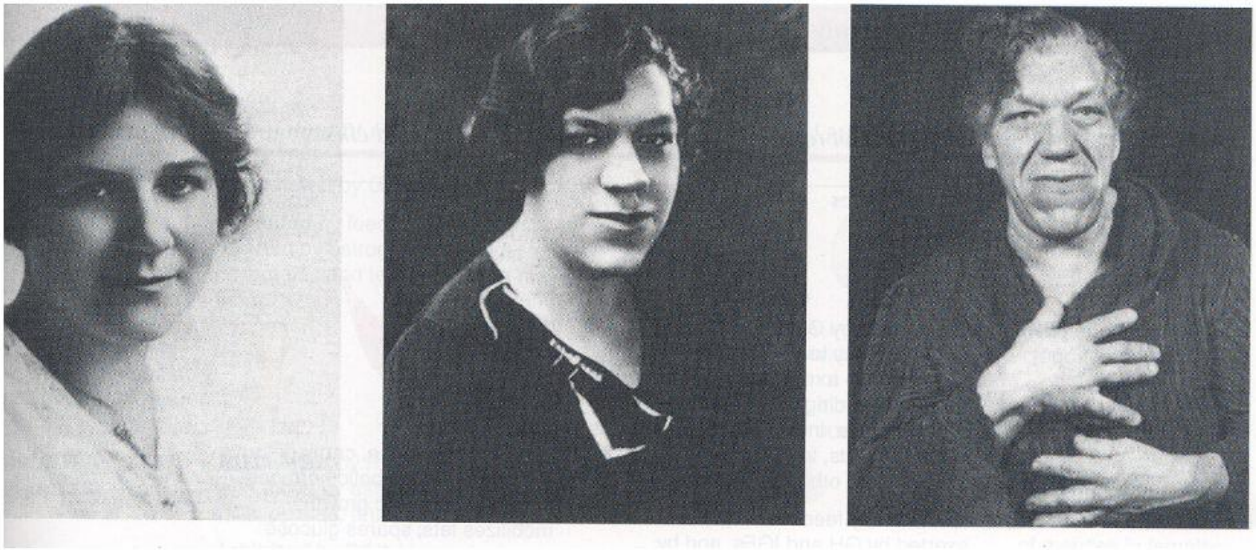
• panhypopituitary dwarfism does not pass through puberty.

• However, only growth hormone is deficient; these persons do mature sexually and occasionally reproduce.

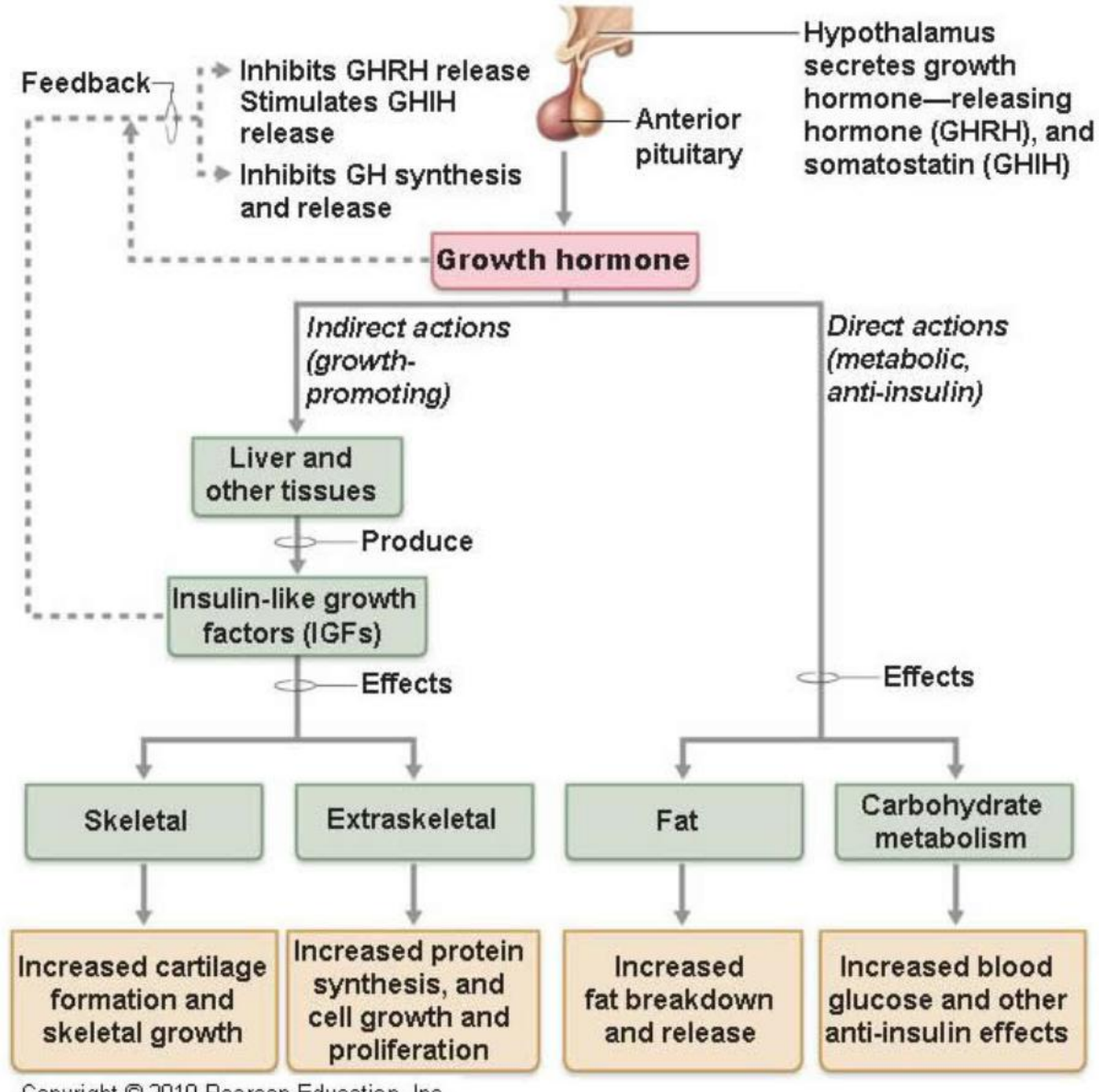
If decreased production in **adulthood** ⟶ **metabolic effects** only



?GH IN AN ADULT



Summary slides



PROLACTIN

FUNCTIONS & CONTROL OF PROLACTIN SECRETION

- Function:

The major function of prolactin is milk production.

- Control of secretion:
  - Release is inhibited by PIH (dopamine).
  - Suckling inhibits PIH release leading to increase prolactin release.

FUNCTIONS OF PROLACTIN

- Effect on the breast:
  - Increases mRNA.
  - Increases production of casein and Lactalbumin.

- Other effects:
  - Stimulates the secretion of dopamine in median eminence (inhibits its own secretion).
  - Inhibits the effects of gonadotropins.

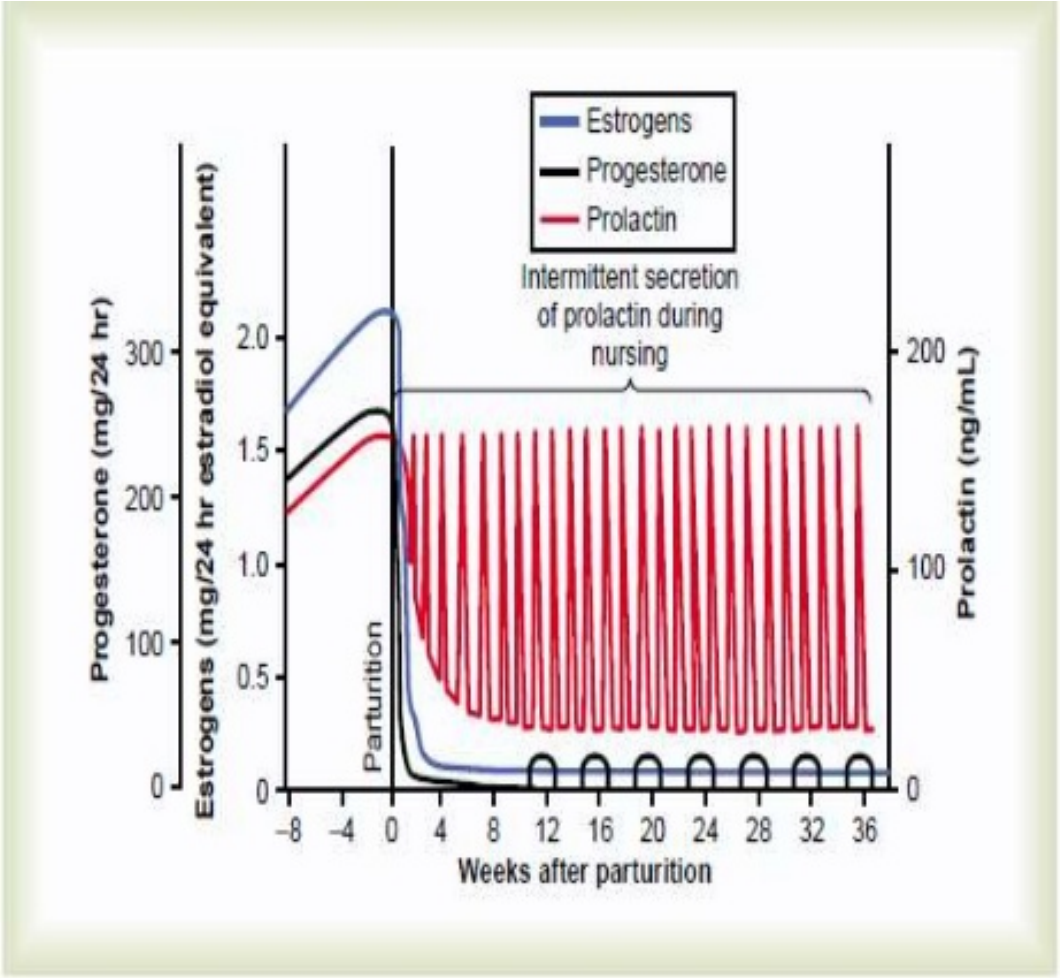


Figure 82–11

Changes in rates of secretion of estrogens, progesterone, and prolactin for 8 weeks before parturition and 36 weeks thereafter. Note especially the decrease of prolactin secretion back to basal levels within a few weeks after parturition, but also the intermittent periods of marked prolactin secretion (for about 1 hour at a time) during and after periods of nursing.

Actions of prolactin:

Highest level is found at term.

1- *During pregnancy*:
- Growth of mammary glands.

(no milk production due to the inhbitory effect of placental hormones)

-2- *After delivery*

PRL initiates and maintains milk production. (suckling stim. PRL release).

3- PRL decreases the sensitivity of ovaries to gonadotrophins leading to suppression of menstrual cycle.
-Occurs in 50% of lactating women.
- physiological birth control.

4- PRL acts on the limbic system producing the characteristic maternal and nursing behavior.

Factors affecting PRL secretion

Factors increasing PRL secretion

- Estrogen (during pregnancy stimulates lactotropes to secrete PRL)
- Breast feeding (reflex increase)
- TRH
- Stress
- sleep / Exercise
- Dopamine antagonists
- chest wall stimulation or trauma

Factors inhibiting PRL secretion

- Dopamine
- Bromocryptine, metoclopramid (Dopamine agonist)
- Somatostatin
- PRL (by negative feedback)