

Anterior pituitary

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Anatomy of the Pituitary

- 3 distinct parts and their functions
 - Anterior pituitary (adenohypophysis)
 - Forms the lactotrophs, somatotrophs, thyrotrophs, corticotrophs and gonadotrophs
 - Intermediate lobe
 - Little functional capacity
 - Posterior pituitary (neurohypophysis)
 - Stores and releases oxytocin and vasopressin (ADH)

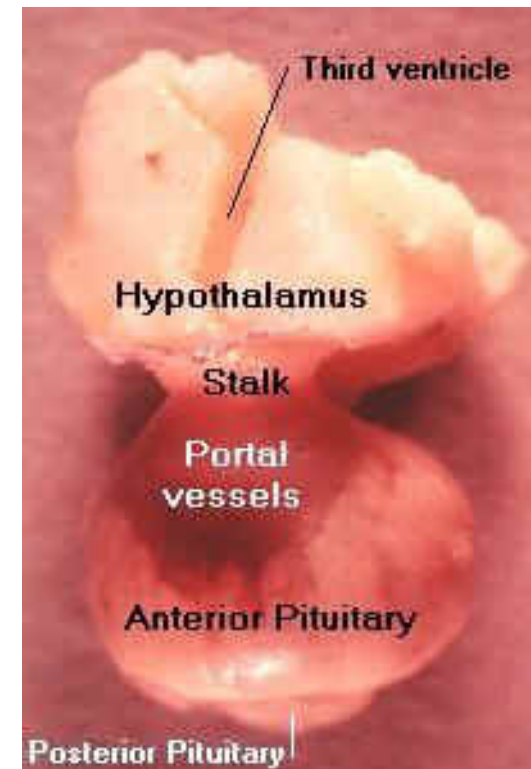
Anterior Pituitary Cell Types and Hormones

Each of anterior pituitary hormone is synthesized by a cell population

- Corticotrophs
 - Release Adrenalcorticotrophic (ACTH)
- Gonadotrophs
 - Release Leutinizing Hormone (LH) and Follicle stimulating hormone (FSH)
- Thyrotrophs
 - Release Thyroid Stimulating Hormone (TSH)
- Lactotrophs
 - Release Prolactin
- Somatotrophs
 - Release Growth Hormone (GH)

Anterior pituitary: adenohypophysis

- **Anterior pituitary:** connected to the hypothalamus by the hypothalamoanterior pituitary portal vessels. .
- The anterior pituitary is collection of hormone producing glandular cells.
- The anterior pituitary produces six peptide hormones:
 - Prolactin (PRL) , growth hormone (GH),
 - thyroid stimulating hormone (TSH),
 - adrenocorticotrophic hormone (ACTH),
 - follicle-stimulating hormone (FSH),
 - luteinizing hormone (LH).



They are Classified into:

- **Somatotropic Hormones:**
 - have similar structure and function
 - 1- lactogenic activity (stimulation of lactation and milk secretion)
 - 2- growth promoting effect
 - 1- Growth Hormone (GH).
 - 2- Prolactin (PRL).
- **Glycoprotein Hormones:**
 - 1- Luteinizing Hormone (LH).
 - 2- Follicle-Stimulating Hormone (FSH).
 - 3- Thyroid-Stimulating Hormone (TSH).
- **Pro-Opiomelanocortin (POMC) derived Hormones:**
 - 1- Corticotropin: ACTH.
 - 2- Melanocyte-Stimulating Hormones: α -MSH, β -MSH.
 - 3- Lipotropins: β -LPH, γ -LPH

Anterior Pituitary Hormones

1-Growth Hormone (GH, Somatotropin): primary hormone responsible for regulating body growth, and is important in metabolism

2-Thyroid-stimulating Hormone (TSH): stimulates secretion of thyroid hormone & growth of thyroid gland

3-Adrenocorticotrophic Hormone (ACTH): stimulates cortisol secretion by the adrenal cortex & promotes growth of adrenal cortex

Anterior Pituitary Hormones

4-Follicle-stimulating Hormone (FSH):

Females: stimulates growth & development of ovarian follicles, promotes secretion of estrogen by ovaries.

Males: required for sperm production

5-Luteinizing Hormone (LH):

Females: responsible for ovulation.

Males: stimulates cell in the testis to secrete testosterone

6-Prolactin:

Females: stimulates breast development and milk production.

Males: involved in testicular function

Growth Hormone

- Also called **somatotropin**
- Peptide with direct effector functions
- Release of GH is **stimulated by hypothalamic hormone GHRH**
 - **Secretion occurs in pulse ~ every 2-3 hours**
 - **Peaks at the onset of sleep**
- Inhibited by **somatostatin (SS) or GHIH**
- Increased secretion in sleep, exercise, trauma & hypoglycemia
- Decreased secretion in hyperglycemia & hypothyroidism

Growth Hormone

Stimulators

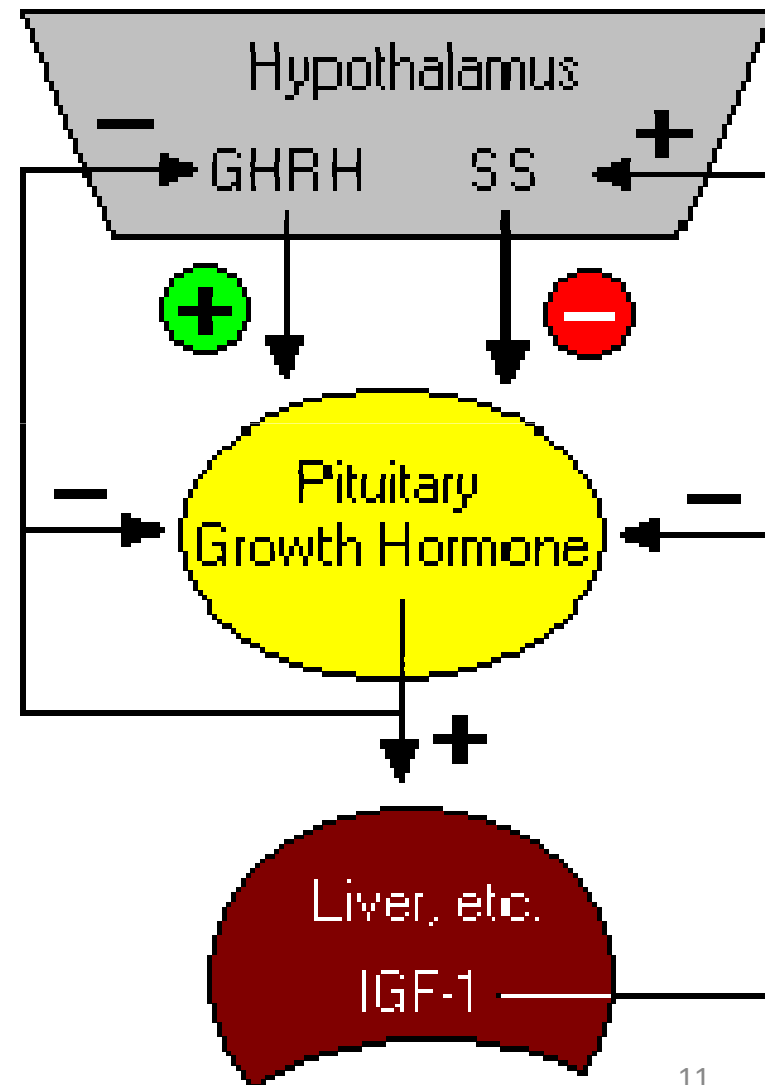
- Trauma
- Exercise
- Sleep
- Hypoglycemia

Inhibitors

- Glucose loading
- Epinephrine
- Emotional/psychogenic stress
- Nutritional deficiencies
- Insulin deficiency
- Hypothyroidism

Growth hormone

- Control (regulation) of GH
 - Stimulation: Growth hormone releasing hormone (GHRH) stimulate secretion of GH
 - Inhibition: Somatostatin (SS) inhibit secretion of GH



- **Secretion:**

Somatotropes of the Anterior Pituitary.

- **Level:**

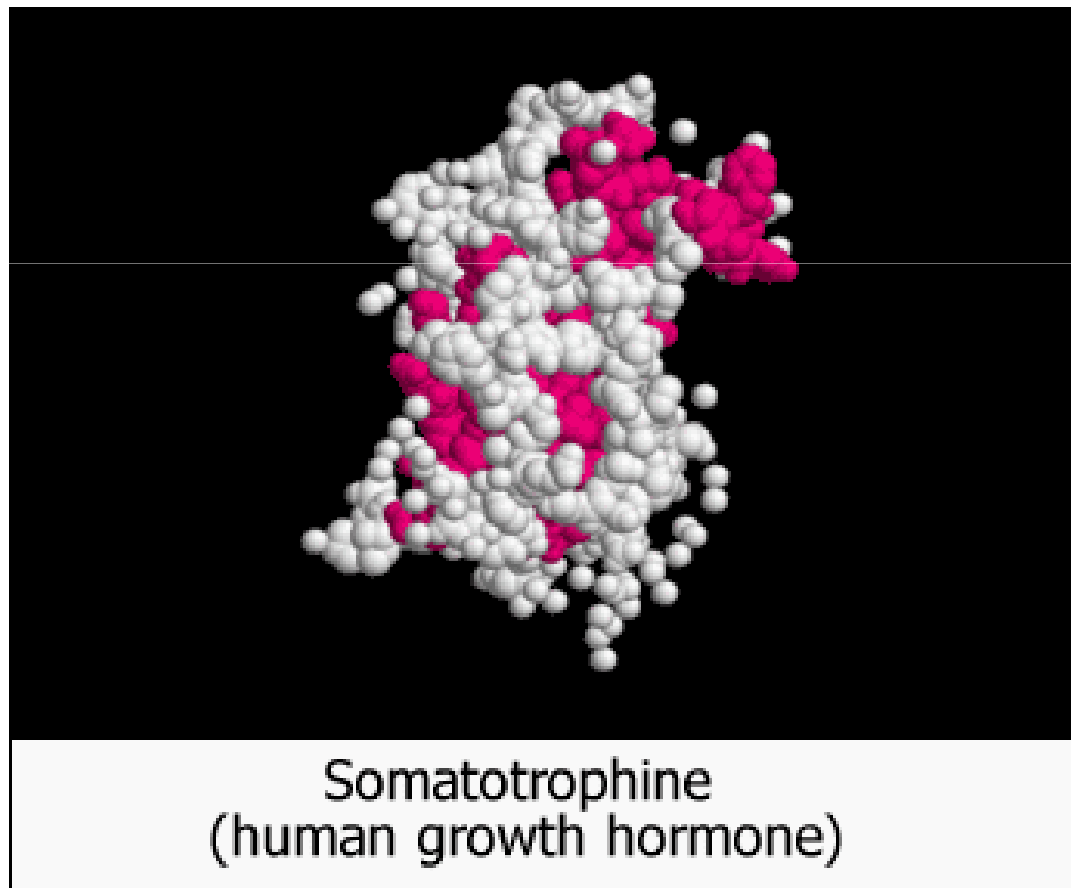
High in children.

Maximal during adolescence.

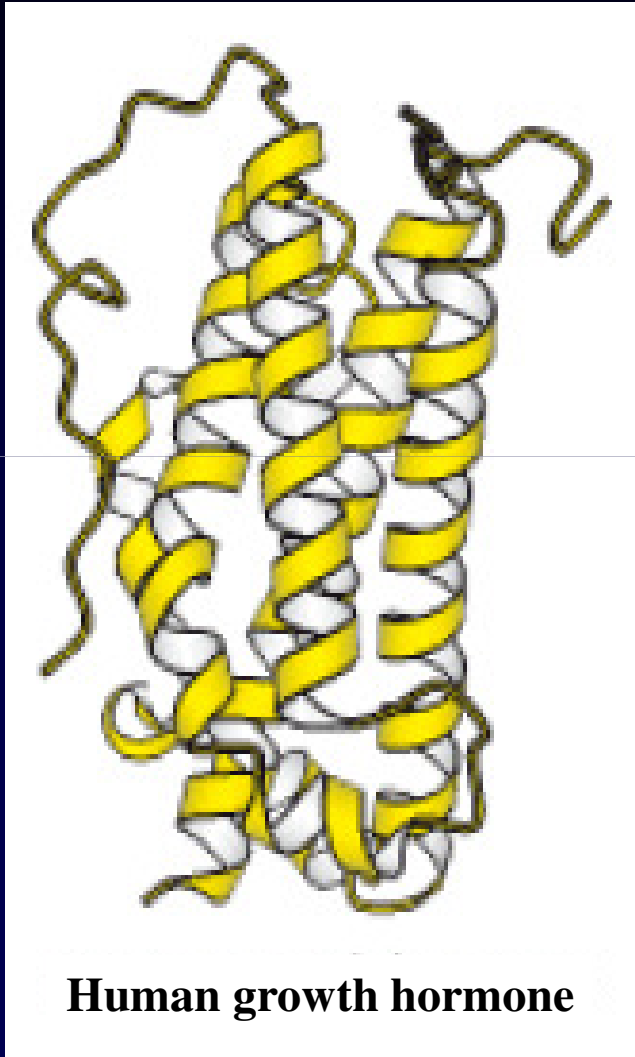
Lowest during adulthood.

Growth Hormone (GH)

- **Structure:** It is a single polypeptide chain composed of 191 amino acid residues. It has two disulfide bonds.



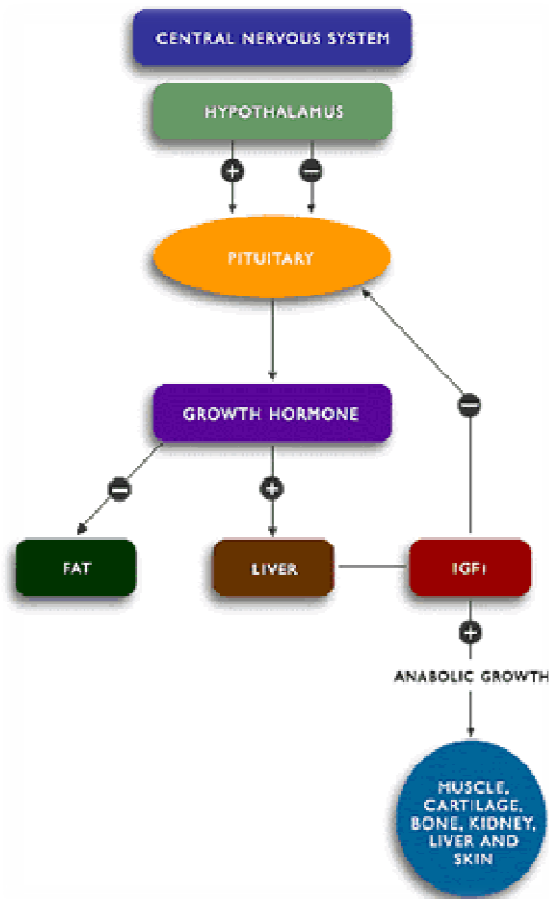
Human growth hormone structure



$p < 0.0001^*$

Human growth hormone forms a four-helix bundle

GROWTH HORMONE (GH)



- Its function varies during the age & mainly in the cell growth proliferation
- Produces somatomedians or insulin-like growth factor-1 (IGF-I) that act as secondary messengers from the liver.

Physiological Effects:

- **Direct Effects:**

- 1- Stimulation of Lipolysis (Hydrolyses of Triglycerides).
- 2- Stimulation of Hepatic glucose output.
- 3- Production of Insulin-like growth factors (IGF's, Somatomedins)

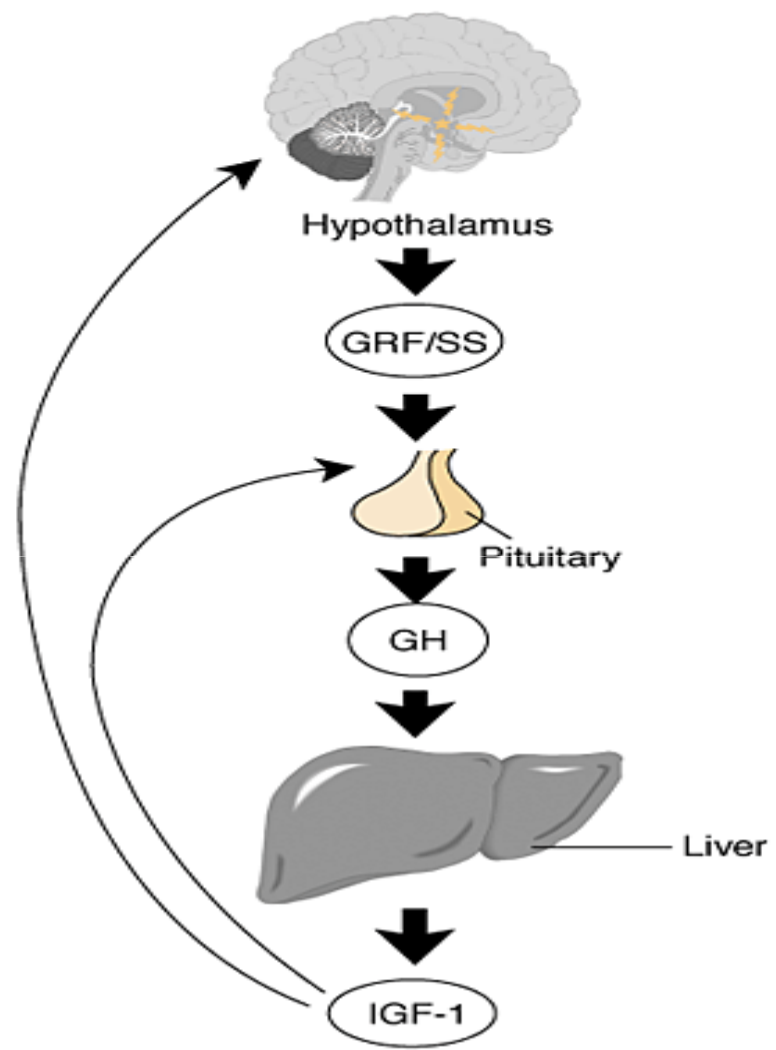
- **Indirect Effects:**

Mediated by IGF-1:

- 1- Increase cell numbers.
- 2- Positive Nitrogen balance.
- 3- Increase Protein synthesis.

Growth Hormones

- GH primary job is to stimulate the liver
 - To secrete IGF-1 (Insulin Growth Factor)
- **IGF-1**
 - stimulates proliferation of chondrocytes (cartilage cells), resulting in bone growth.
 - differentiation and proliferation of myoblasts(muscles)
 - Stimulates amino acid uptake and protein synthesis in muscle and other tissues.



Growth Hormone Activity

- 1-Amphibolic:** influences both anabolic & catabolic processes
- 2- Increases plasma free fatty acids (FFA) - source of energy for muscle tissue (Stimulates **lipolysis**)
- 3- Increases hepatic glucose output (Provides **hepatic gluconeogenesis**)
- 4- Decreases insulin sensitivity in muscle
- 5- Directly **antagonizes effect of insulin on glucose metabolism**(GH causes inhibition of glucose uptake and utilization)

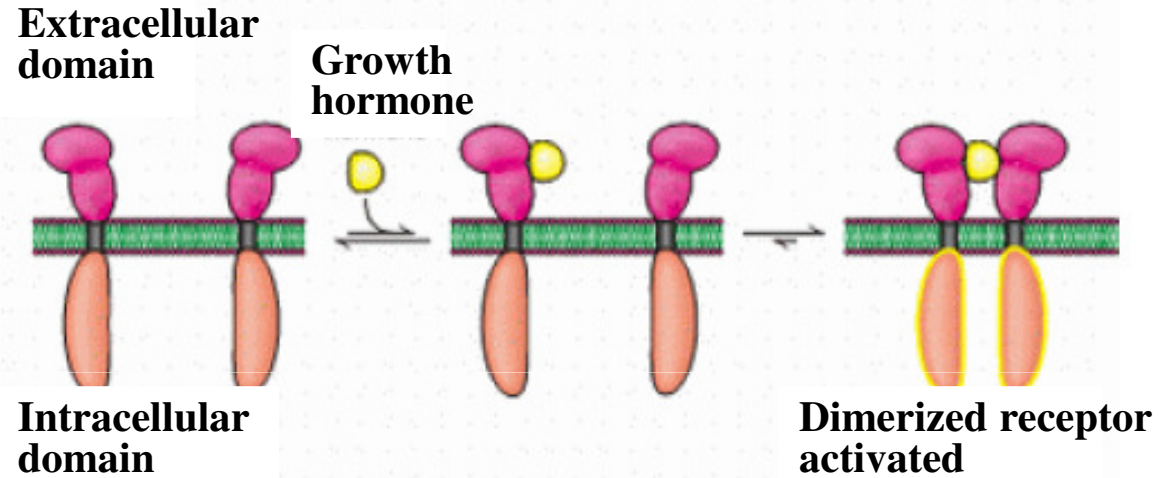
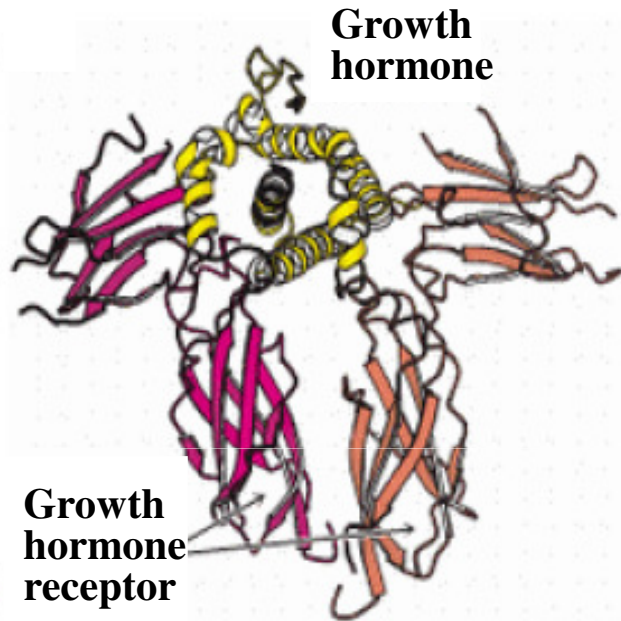
Growth Hormone Activity

6- Increase a.a. uptake and protein synthesis in skeletal muscle & other tissues (Is **protein anabolic** hormone)

7- Stimulates **production of IGF-I** from the liver; IGF-I is also locally produced in other tissues

8- Exerts its **growth-promoting** mainly through induction of Insulin-like Growth Factor I (IGF-I)].

Binding of growth hormone leads to receptor dimerization



Disease Conditions Related to GH:

- **Deficiency:**

- * **Dwarfism:** More serious in infancy, the affected infants fail to grow properly .

- **Excessive Secretion:**

- * **Giantism:**

- Due to tumor in somatotropes in young children or adolescents (**Before puberty**), rapid growth of long bones.

- * **Acromegaly: (After puberty, stop of long bone growth)**, Rapid growth of flat bones, protruding jaws, enlarged nose, enlargement of hands, feet & skull

- Rare disease (3/Million).

- Causes:** Benign tumor of Pituitary gland (90%).

- Symptoms:** Enlargements of extremities.

Giantism



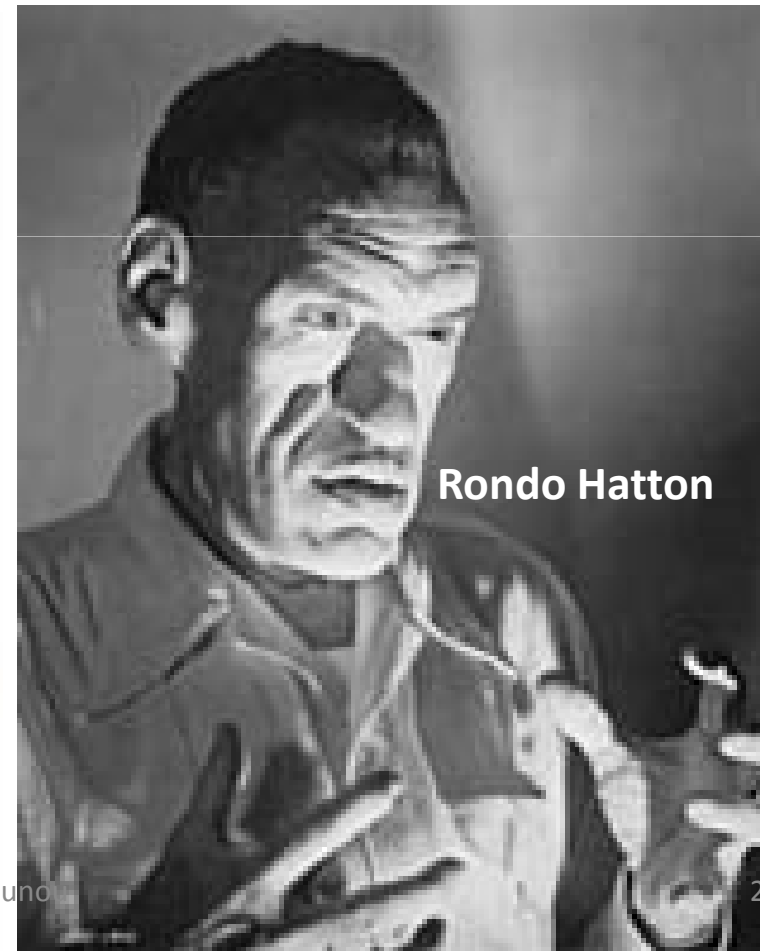
- Excessive GH during childhood



- Tumor of somatotrophs

Acromegaly

- GH late in life
- Causes excessive growth of flat bones



- **Uses of Growth Hormone:**
 - * Replacement therapy for children with GH deficiency.
 - * Administered by intramuscular or subcutaneous.

- **Sources:**
 - * Recombinant DNA technology.