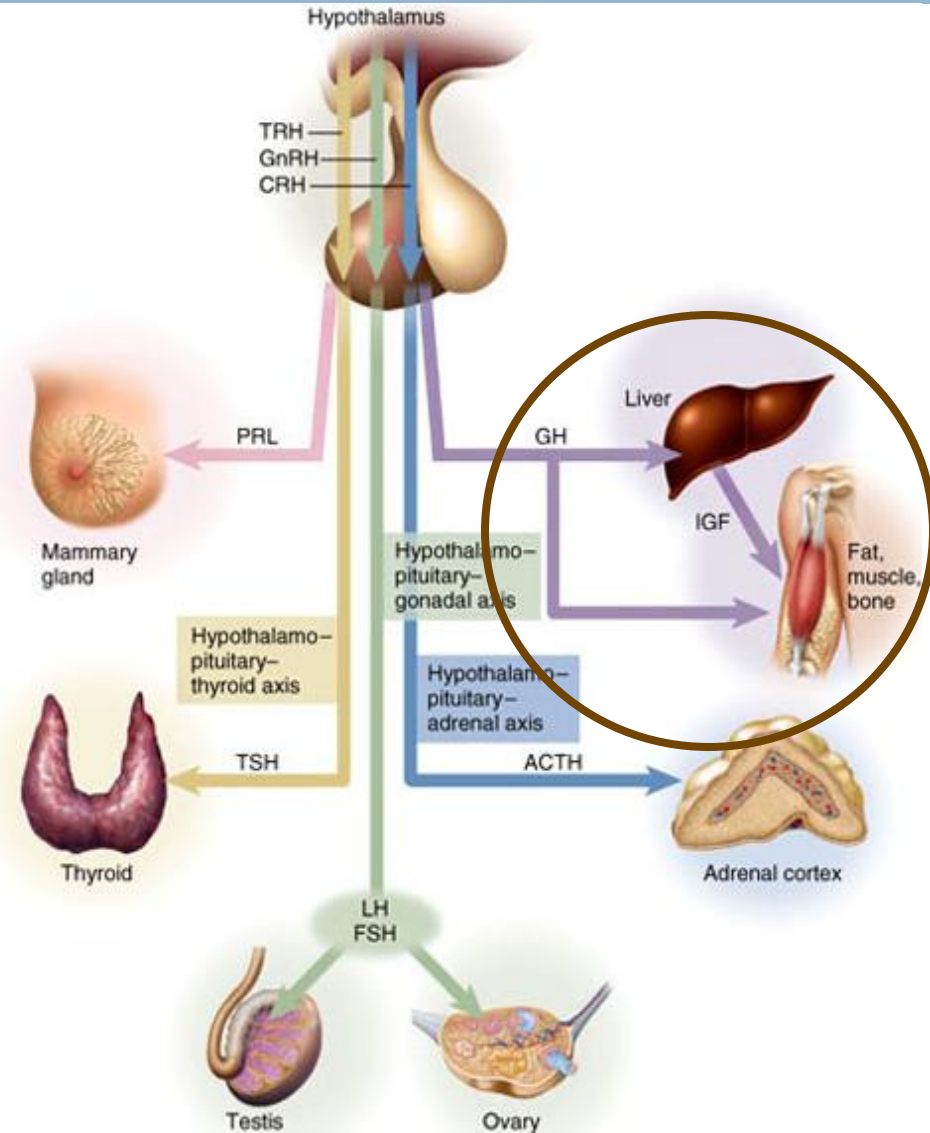
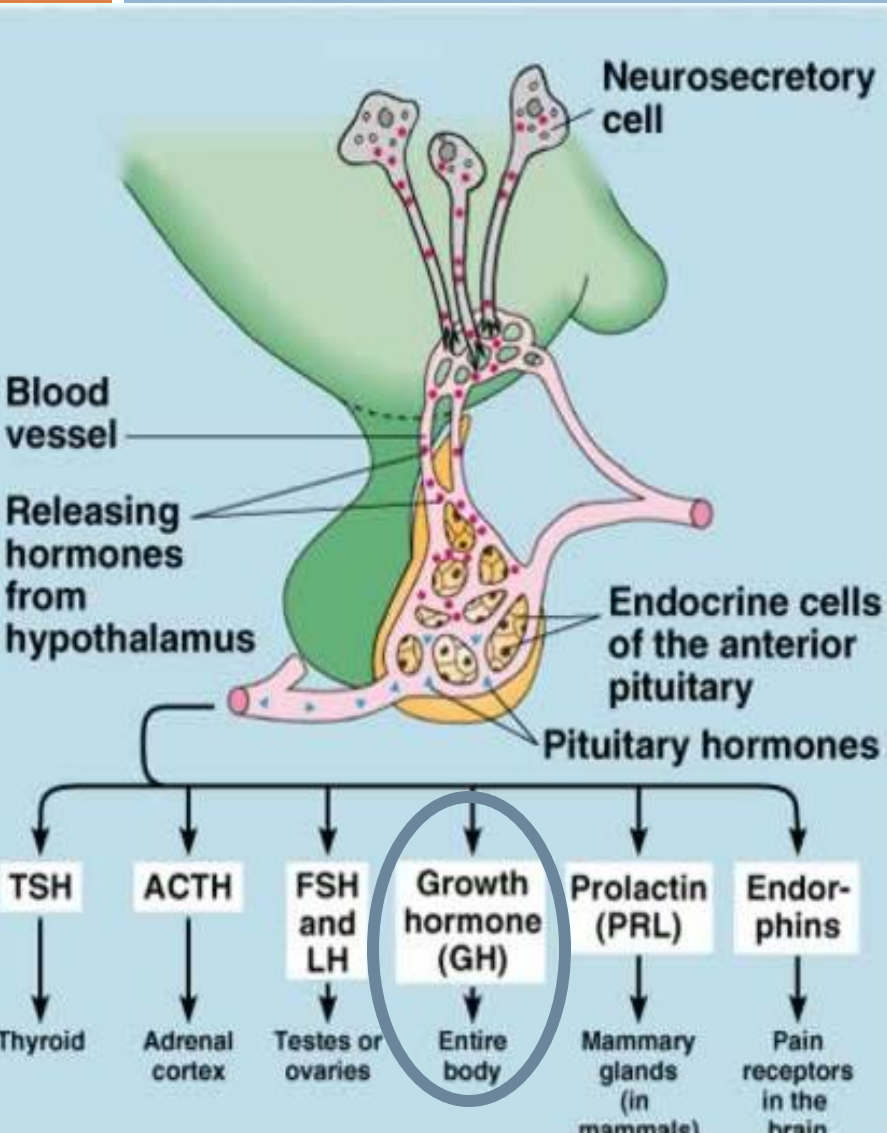


# Endocrine System

## Growth Regulation

# Growth Regulation



# Growth Regulation: Neuroendocrine pathway

Location	Hormone
Hypothalamus	Growth hormone release hormone (GHRH) Growth hormone inhibiting hormone (GHIH) = <b>somatostatin</b> (SS)
Anterior Pituitary	Growth hormone (GH) = <b>somatotropin</b>

# Growth hormone (GH)

- A peptide hormone (~200 amino acids)
- Also known as **somatotropin**:
  - tropic hormone that affects somatic cells

# GH Function: Direct Effect (nontropic)

- GH binds directly to its target cells: bones & muscles
- Stimulates growth
  - **Hypertrophy**: increase in size/volume of cells
  - Example: increase in bone thickness
- Stimulates cell reproduction
  - Increased rate of mitosis
  - **Hyperplasia**: increase in number of cells, proliferation rate
  - Example: increase in bone length
- Stimulates cell metabolism
  - Increase glycogen and fat breakdown for energy
  - Increase protein synthesis

# GH Function: Indirect Effect (tropic)

- Most growth occurs through the indirect method
- GH acts as a tropic hormone
- Signals the liver to produce Insulin-like Growth Factors (IGF)

# IGF-1: Insulin-like Growth Factor 1

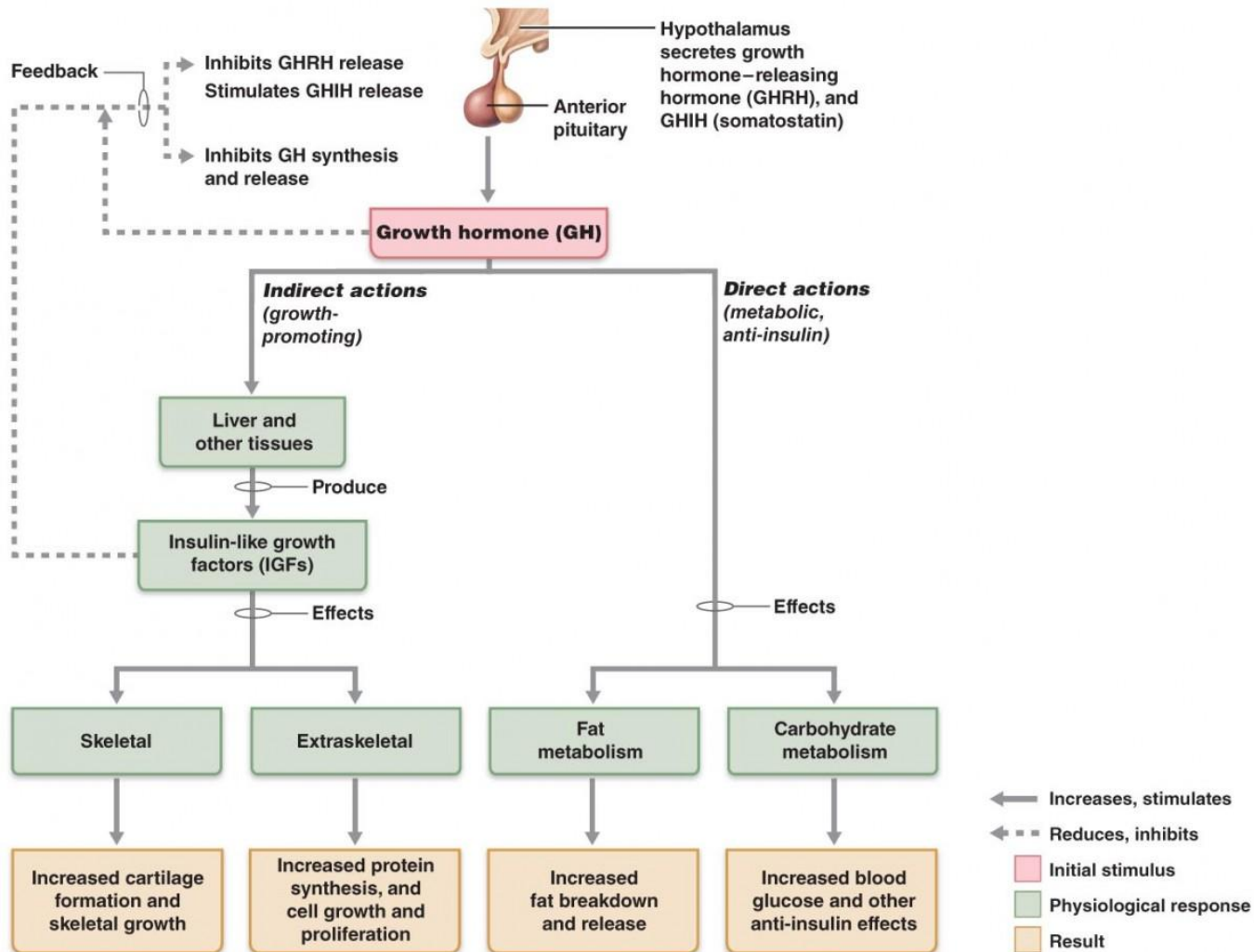
- targets almost every cell in the body including the muscle, cartilage, bone, and skin cells
- Stimulates hypertrophy and hyperplasia of the cells

# Growth Regulation: Neuroendocrine pathway

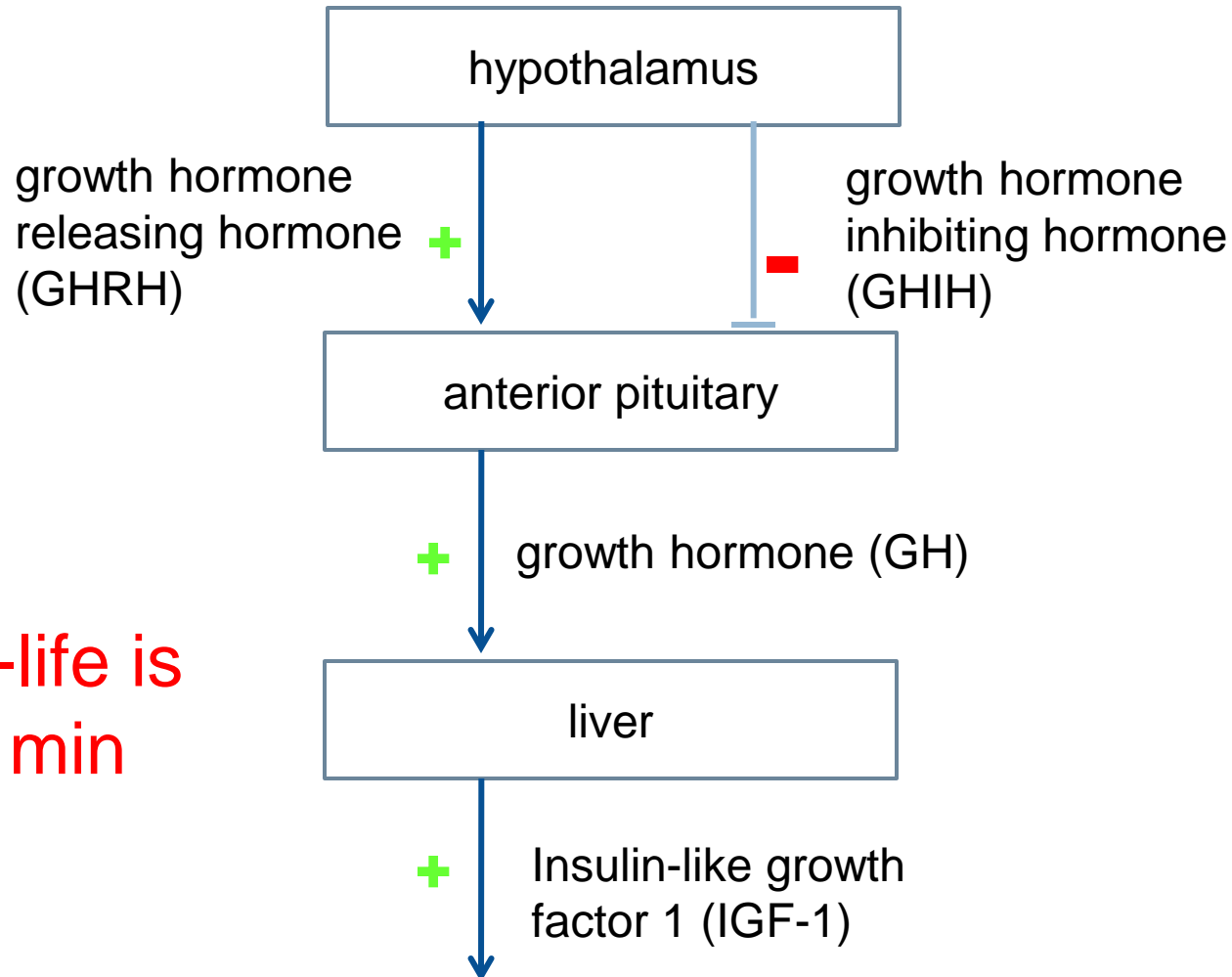
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Hypothalamus	Growth hormone release hormone (GHRH) Growth hormone inhibiting hormone (GHIH) = <b>somatostatin</b> (SS)
Anterior Pituitary	Growth hormone (GH) = <b>somatotropin</b>
Liver	Insulin-like growth factor (IGF)



# Growth Hormone Regulation

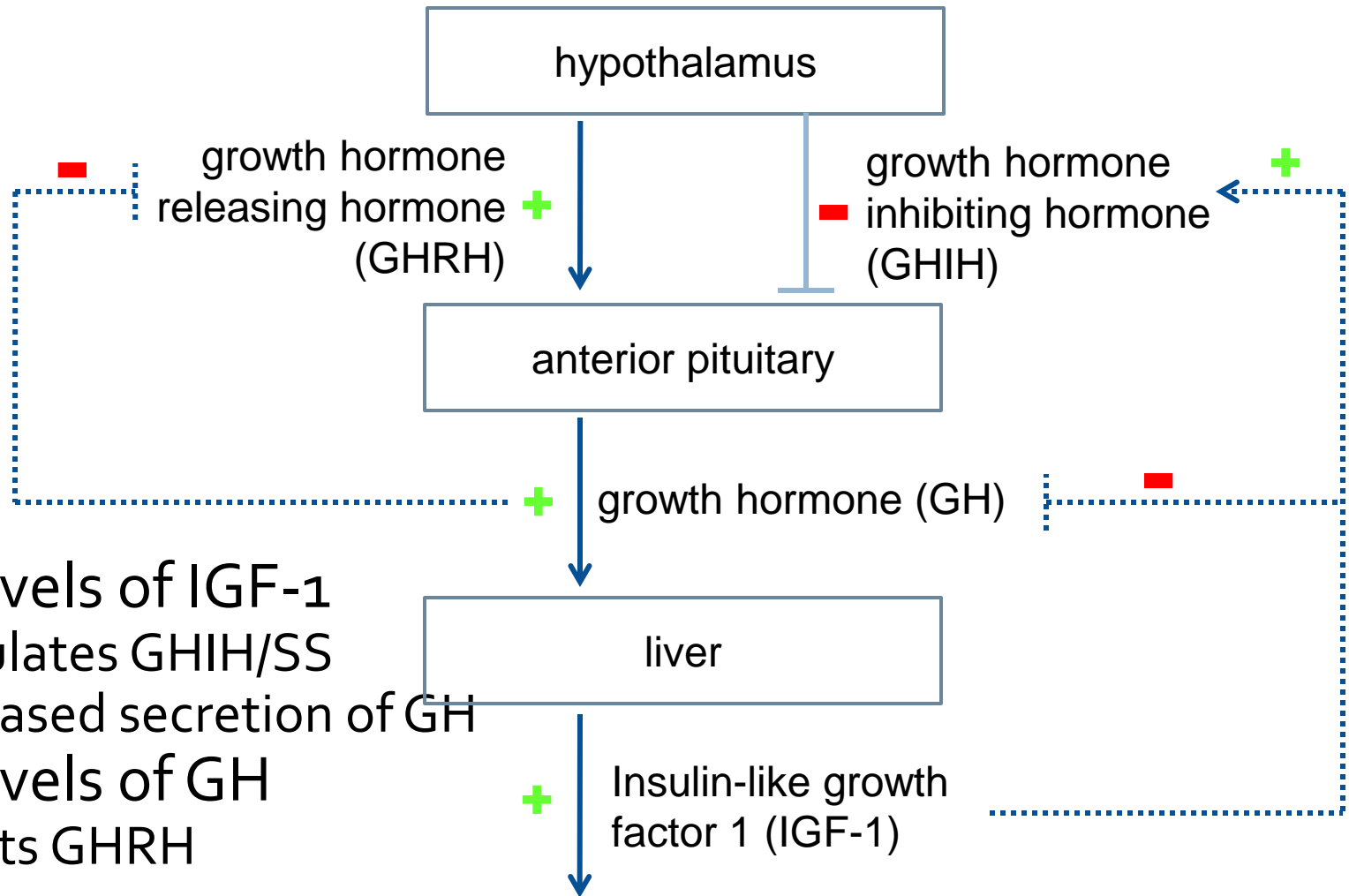


# Growth Hormone Regulation



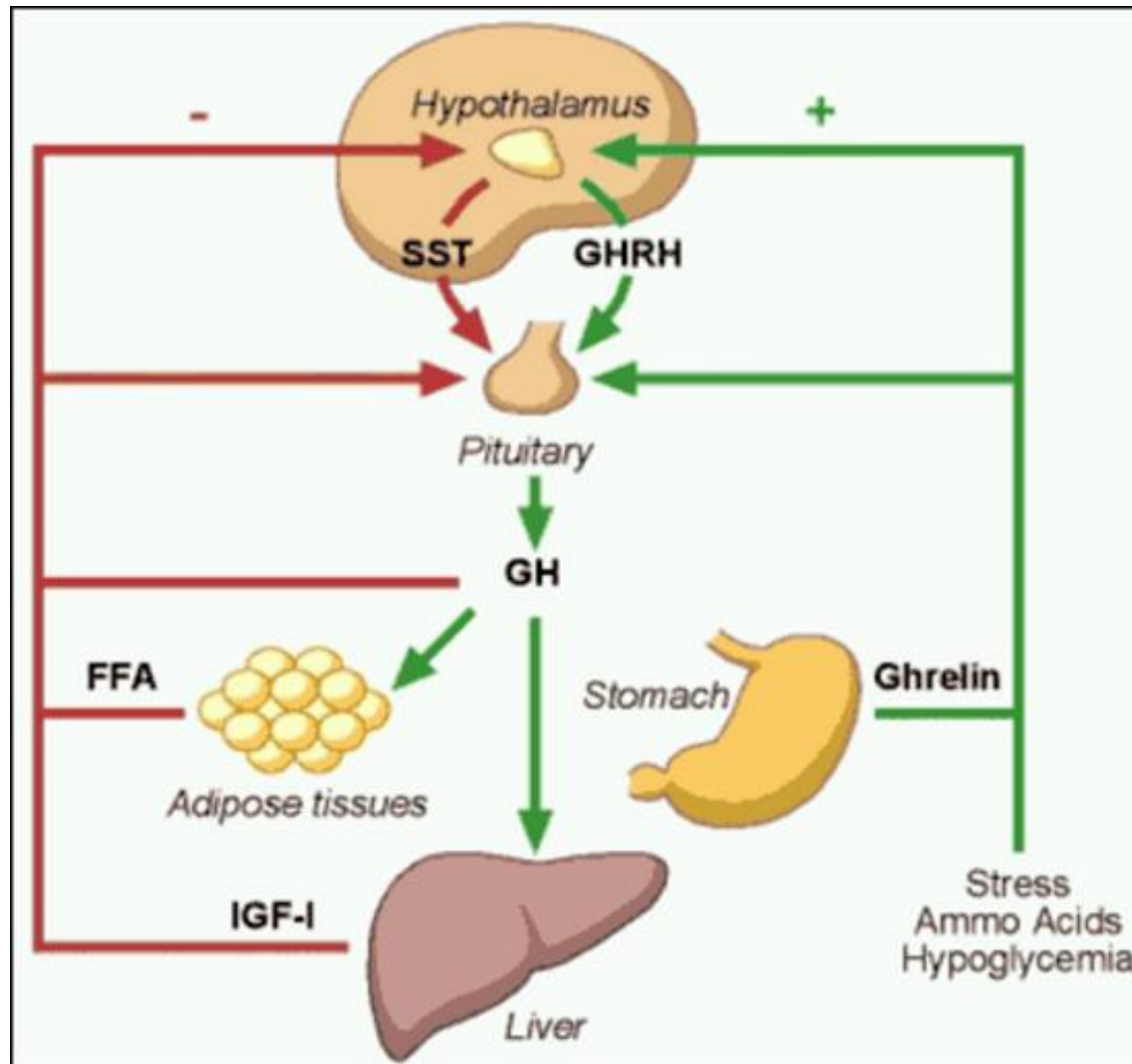
**GH half-life is  
20 – 30 min**

# Negative Feedback

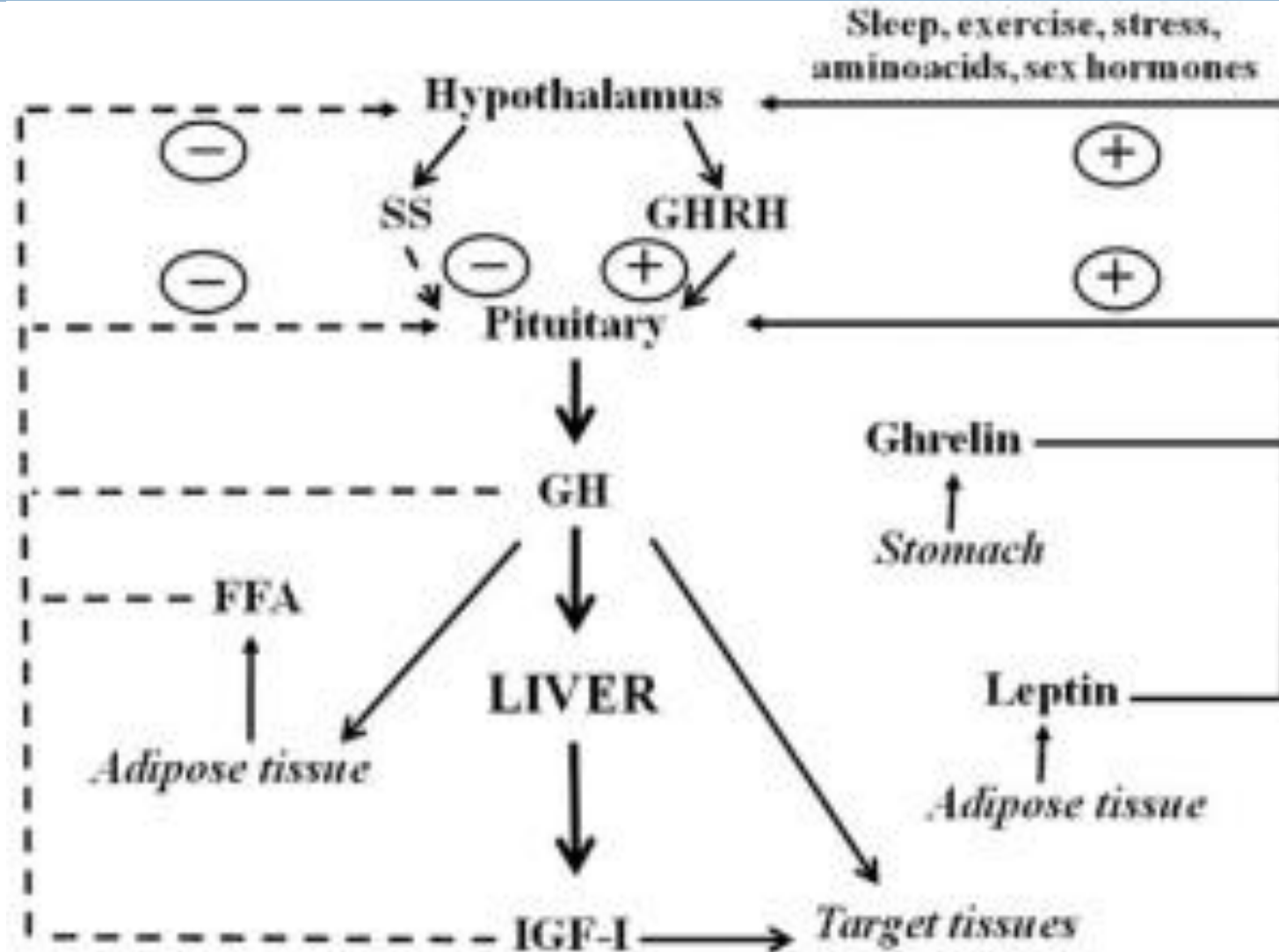


- High levels of IGF-1
  - Stimulates GHIH/SS
  - decreased secretion of GH
- High levels of GH
  - inhibits GHRH

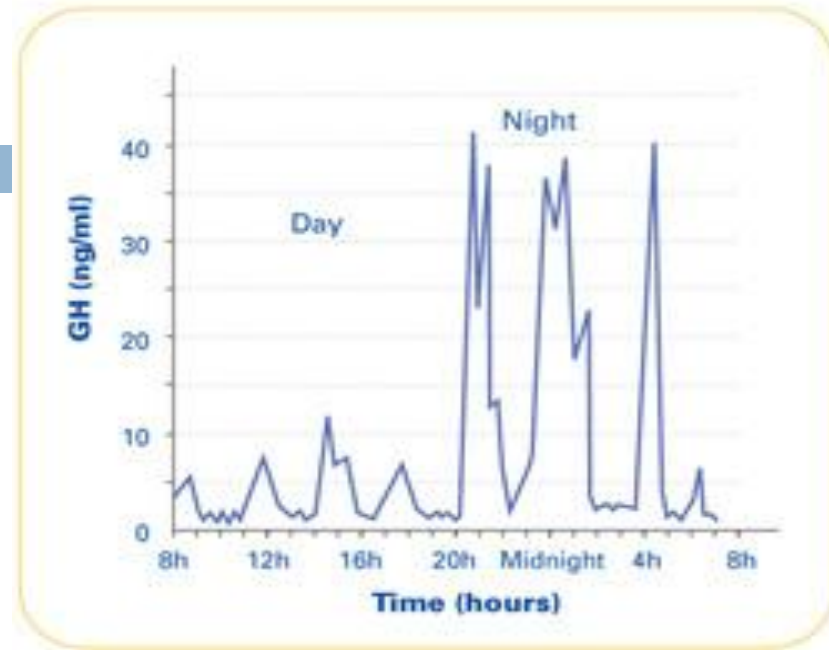
# Growth Hormone Regulation



# Growth Hormone Regulation

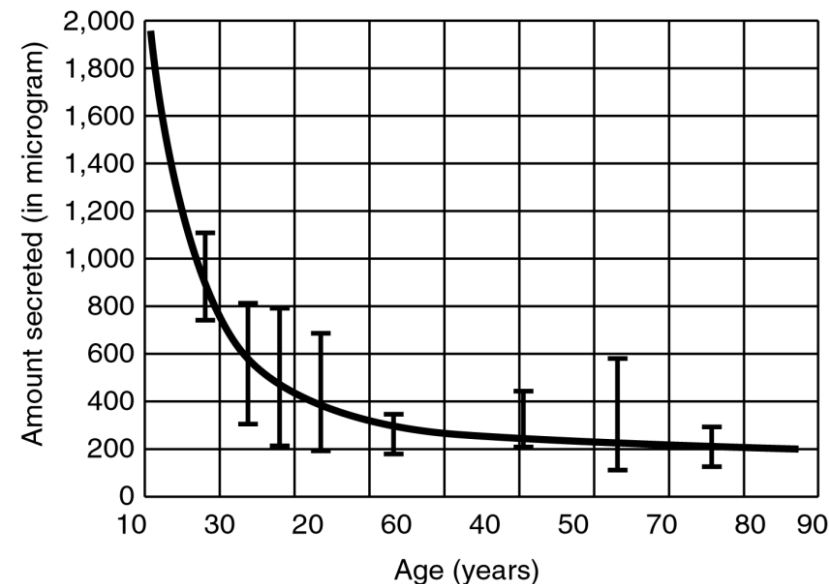


## Normal Secretion of Growth Hormone Over 24 Hours



- Secreted in bursts (not continuous)
- GH is released most during sleep
  - optimal at night time
  - Changing sleeping pattern affects GH release
- GH production declines with age

## Growth Hormone Decline



# Increasing GH Production

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- Exercise regularly
- 8 hours of sleep
- Protein-rich diet
- Avoid Stress

# GH Associated Disorders

- Dwarfism
  - Proportionate
  - Disproportionate
- Gigantism
- Acromegaly





# Dwarfism

- Over 200 different types/causes:  
<http://lpamrs.memberclicks.net/dwarfism-types>
- Classified into 2 major types:
  - **Proportionate** dwarfism: the person is proportionately small all over
  - **Disproportionate** dwarfism: some shorter/smaller parts of the body mixed with average sized parts of the body

# Proportionate Dwarfism: Growth Hormone Deficiency

- aka pituitary dwarfism
- **GH absent** during child's development
- Proportional body
- Short stature
  - Adult 4'10" or shorter



# Disproportionate Dwarfism: Achondroplasia

- most common type of dwarfism (70%)
- autosomal dominant
- mutation on chromosome 4
- caused by a gene mutation that affects **long bone** growth



# Achondroplasia

- Born normal size but skeleton takes on different shapes when growing up
  - Head is bigger than average
  - Torso is average
  - Limbs are shorter
- Fibula (outer leg bone) grows longer than Tibia (inner leg bone)
  - Causes legs to bend outward
  - Causes distinctive walking of waddling and shorter steps
  - Requires more energy to walk

# Gigantism – Vertical Growth

- Excessive growth and height
- Continuous secretion of GH
- Open epiphyseal plate
  - Affects bone growth length
- Occurs during childhood



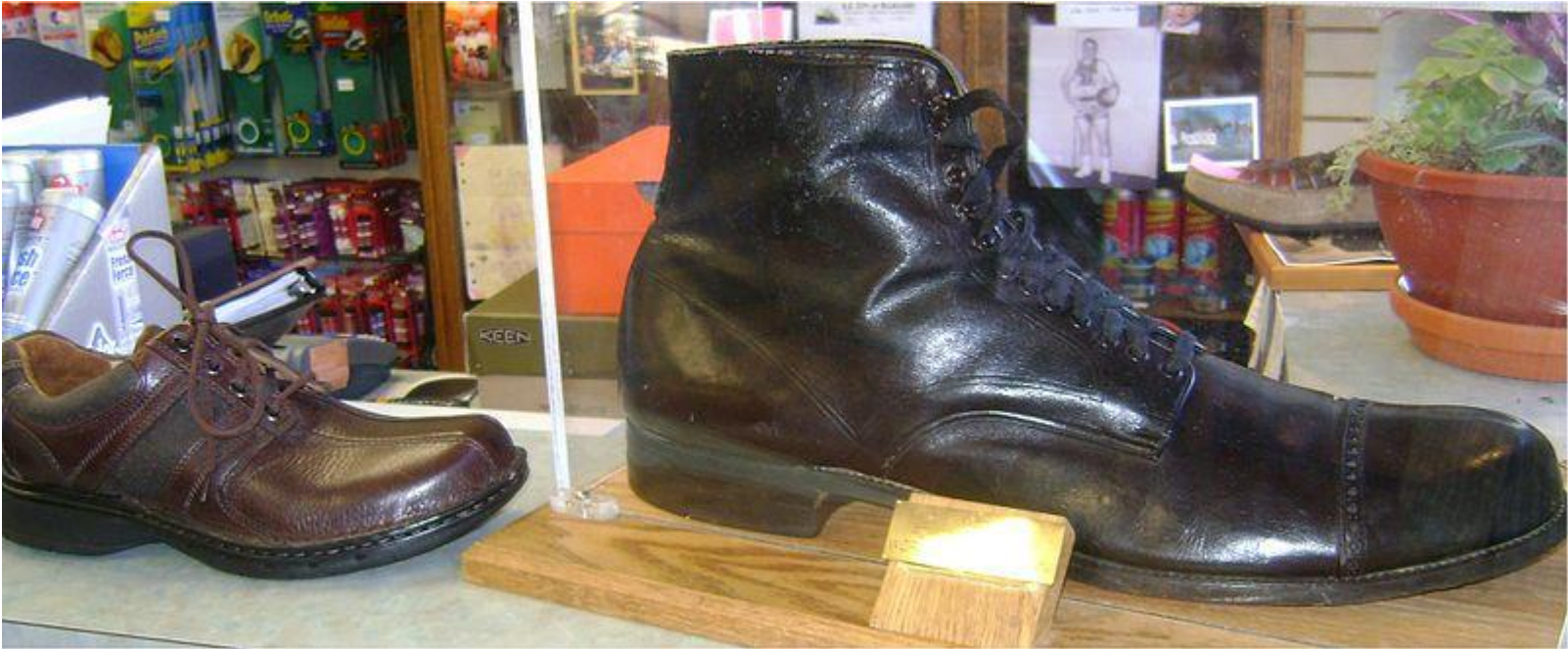
# World's Tallest Man: Robert Wadlow (1918-1940)



8 feet 11 inches and 439 pounds when he died



# World's Tallest Man: Robert Wadlow (1918-1940)



Size 12

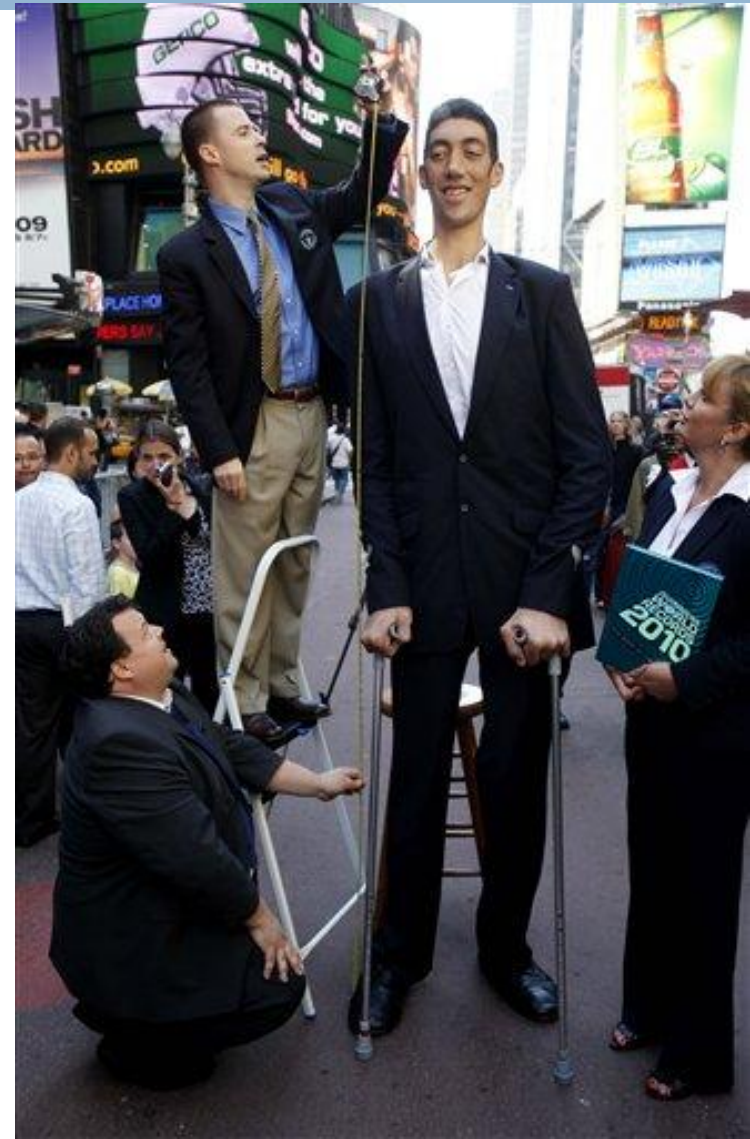
Size 25

# Tallest person alive

- Sultan Kösen
- born in Turkey
- 8 feet 1 inch

<http://www.youtube.com/watch?v=ODFHC2XCtjU>

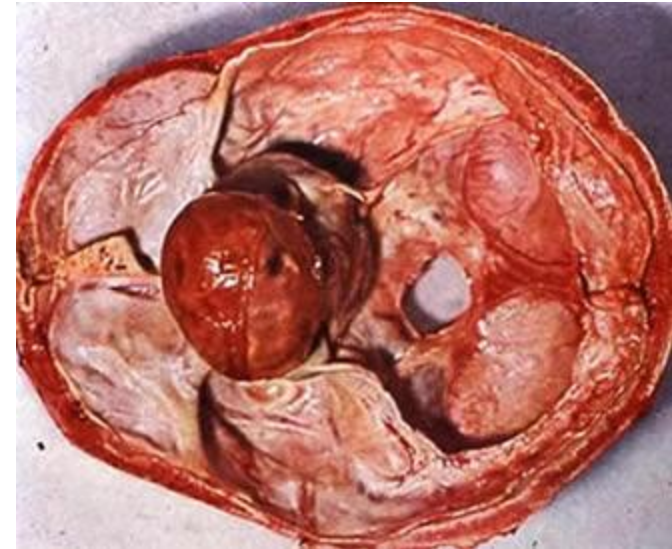
<http://www.youtube.com/watch?v=Rf-lcBzZwC4>





# Gigantism Cause

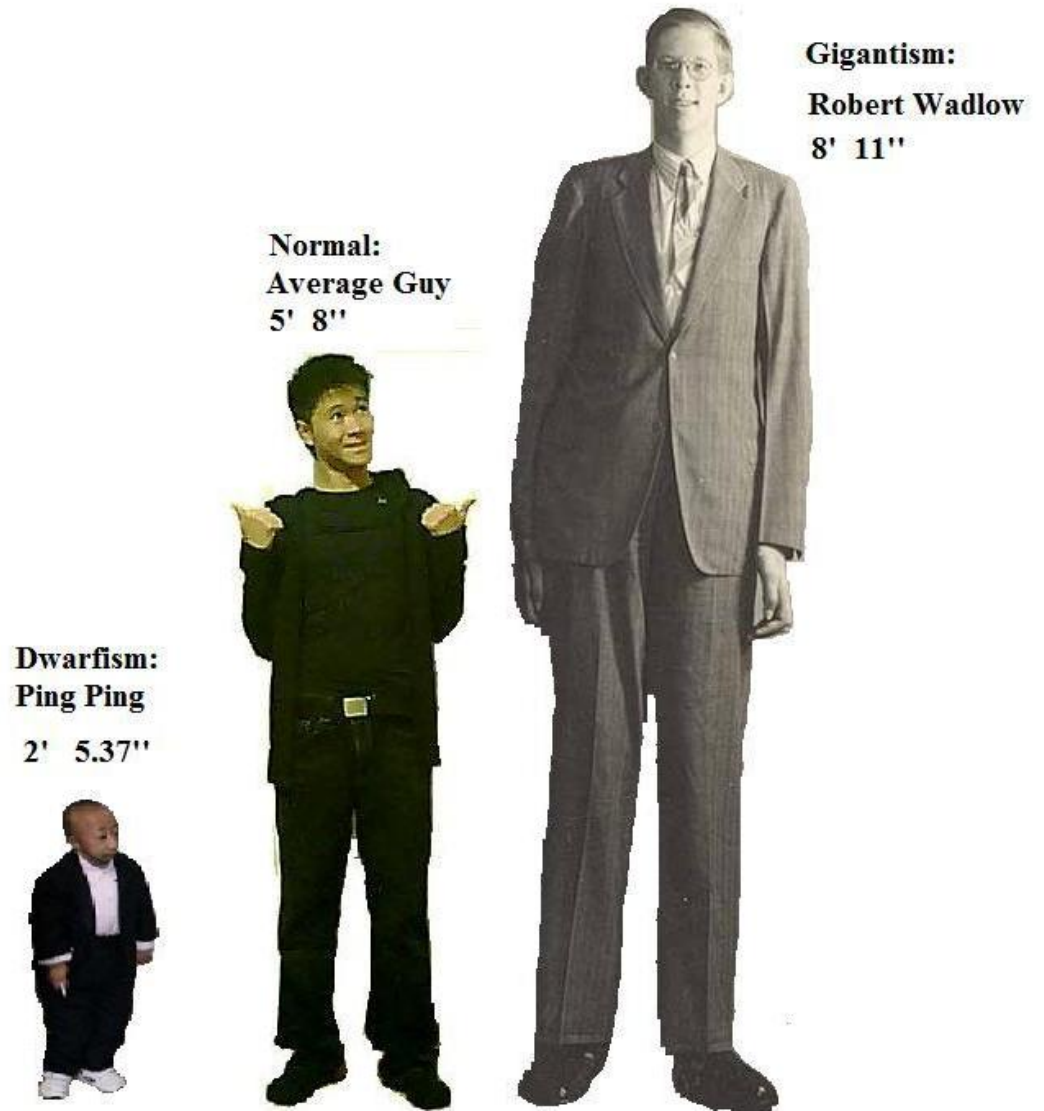
- Pituitary Adenoma
  - Tumour formed by pituitary gland
  - Secretes excessive GH / IGF-1
  - Non cancerous
- Average brain size
  - Skull grows but brain size stays the same, thus the brain function is unchanged



# Gigantism Problems

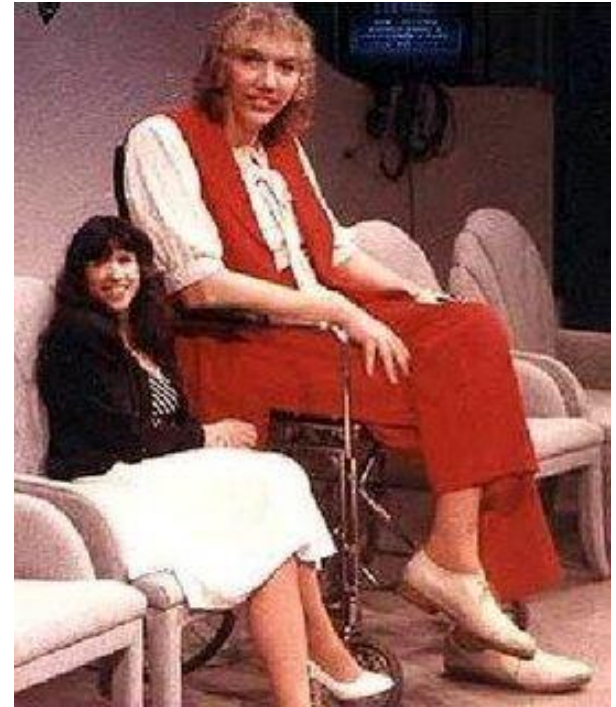
- Poor blood flow due to large body
- Increased muscle mass but weaker muscle
  - Excess GH produces salt in muscle tissues
  - Muscles swell with water
  - Results in disproportional muscle growth → weaker muscles

# Comparing Growths



# Acromegaly – Lateral Growth

- Increased GH secretion as an adult
- Closed epiphyseal plate
  - Bone lengthening stopped
- Bone width increases
- Slow progression



# Acromegaly: Physical Effects



## ■ Bone thickens

- Forehead expands
- Eyebrow ridges bulge outwards
- Cheekbones more prominent
- Bottom jaw enlarges and pushes lower teeth outwards and become widely space



# Acromegaly: Physical Effects

- Soft tissue harden
  - Deeper voice because larynx enlarges
  - Bigger tongue and lips that affects breathing
  - Cartilage in nose enlarges making nose broader

# Acromegaly: Effect on Muscles

- Impaired Movements
  - Enlargement of bones crushes peroneal nerve in knee
  - Nerve carries messages to move foot and lower leg
  - Nerve cannot send messages to leg to trigger walking motion
- Also cause muscle numbness
- Leads to early death





# Acromegaly: Heart Defects

- Heart tissue stiffen
  - heart cannot contract and relax
  - Ventricle harder to fill up
- Heart grows bigger in order to pump out sufficient blood



# Acromegaly: Lung Defects

- As bones grow, rib cage expands
- Diaphragm is stretched thin and loses elasticity
- Breathing is reduced

