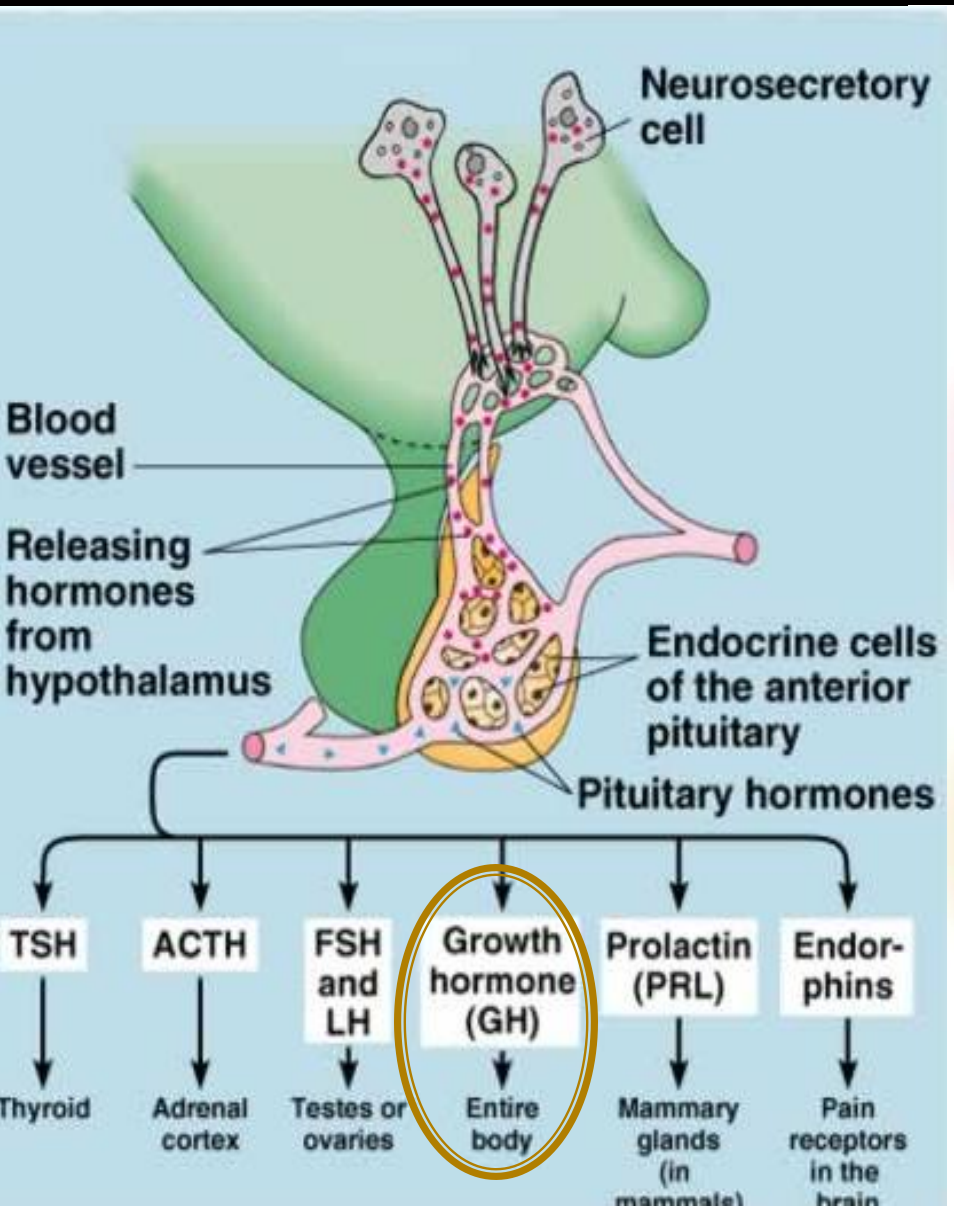
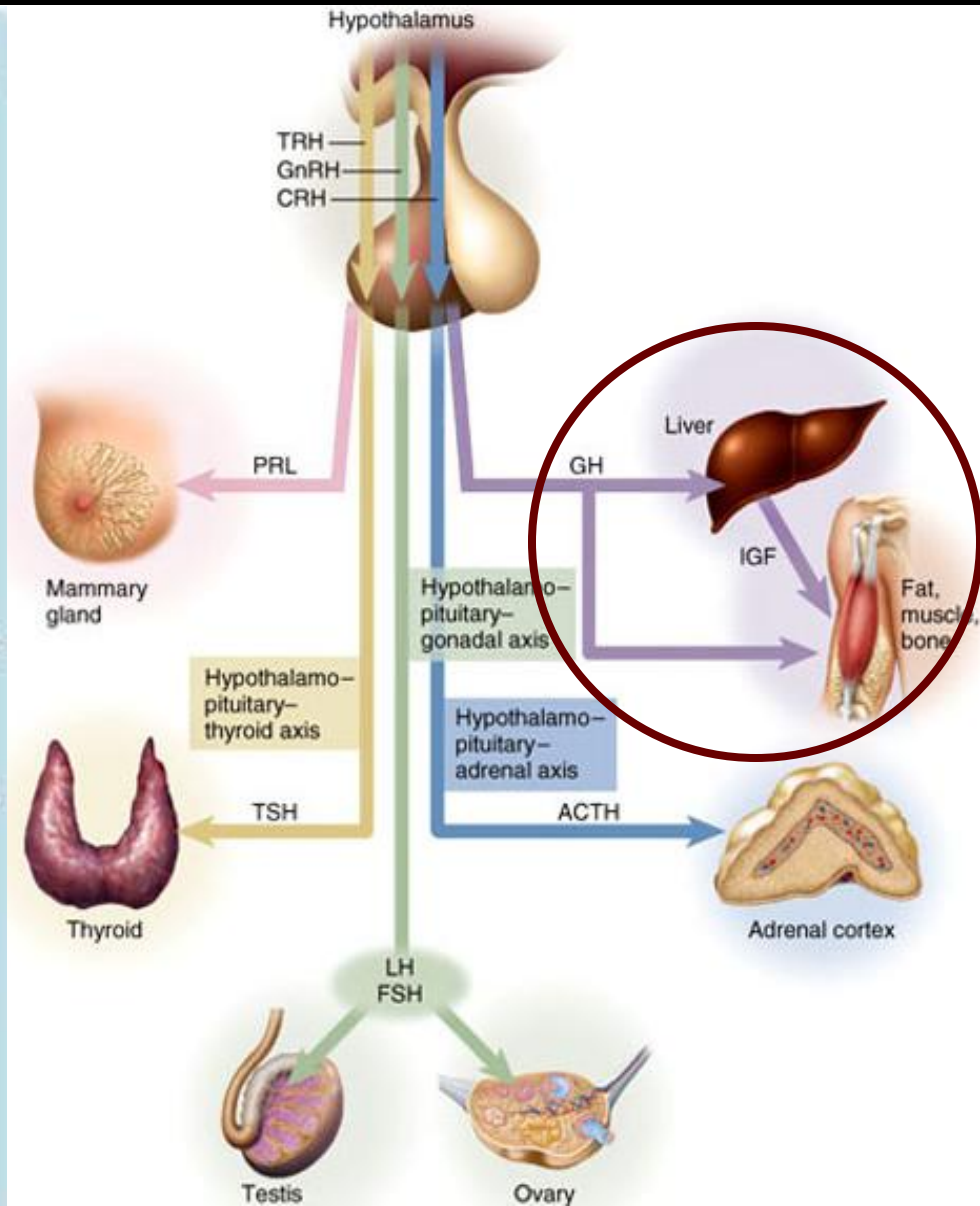
Endocrine System

Part 4: Growth

Growth Regulation





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)

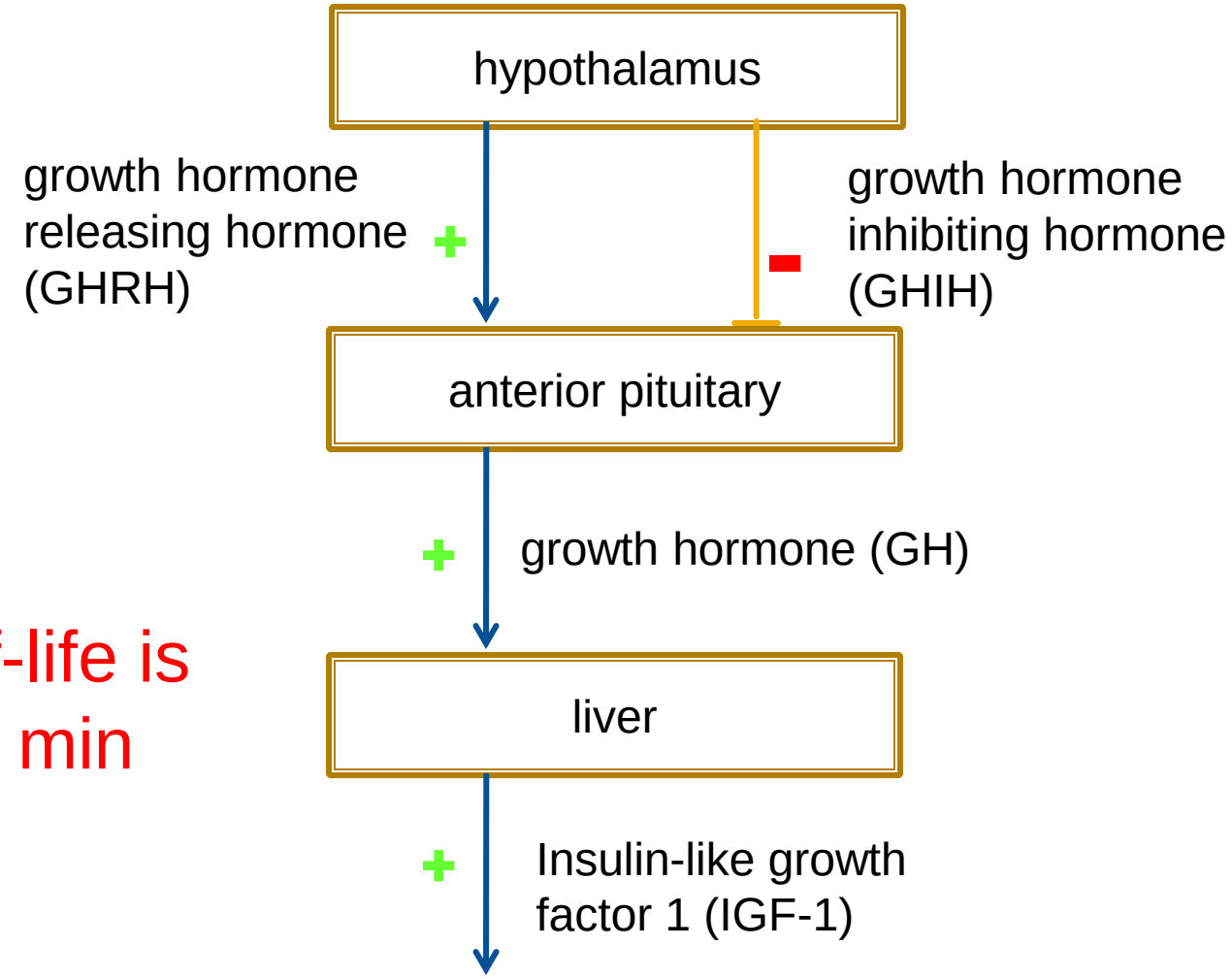
IGF-1: Insulin-like Growth Factor 1

- 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

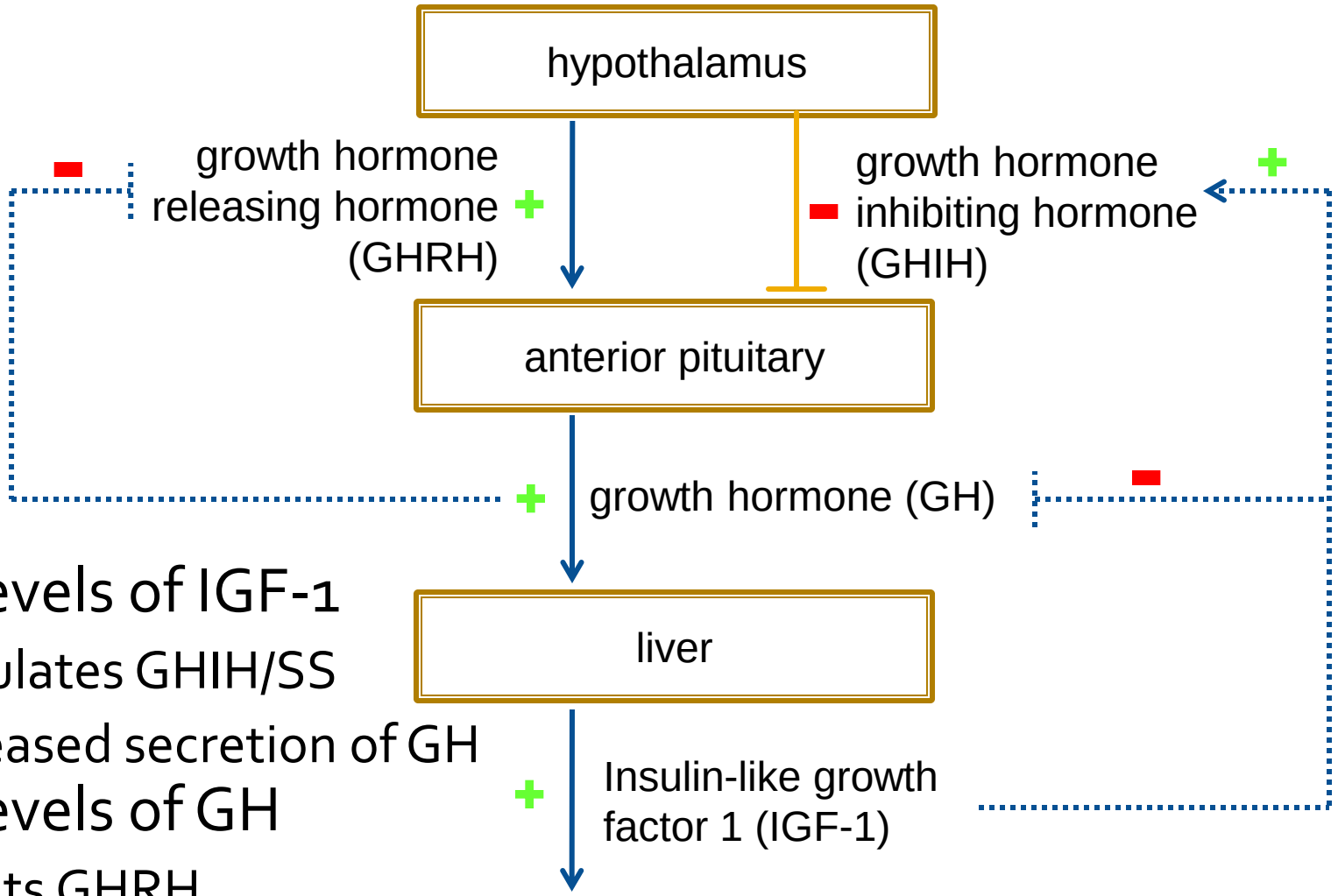
Location	Hormone
Hypothalamus	Growth hormone release hormone (GHRH) Growth hormone inhibiting hormone (GHIH) = **somatostatin** (SS)
Anterior Pituitary	Growth hormone (GH)
Liver	Insulin-like growth factor (IGF)

Growth Hormone Regulation



GH half-life is 20 – 30 min

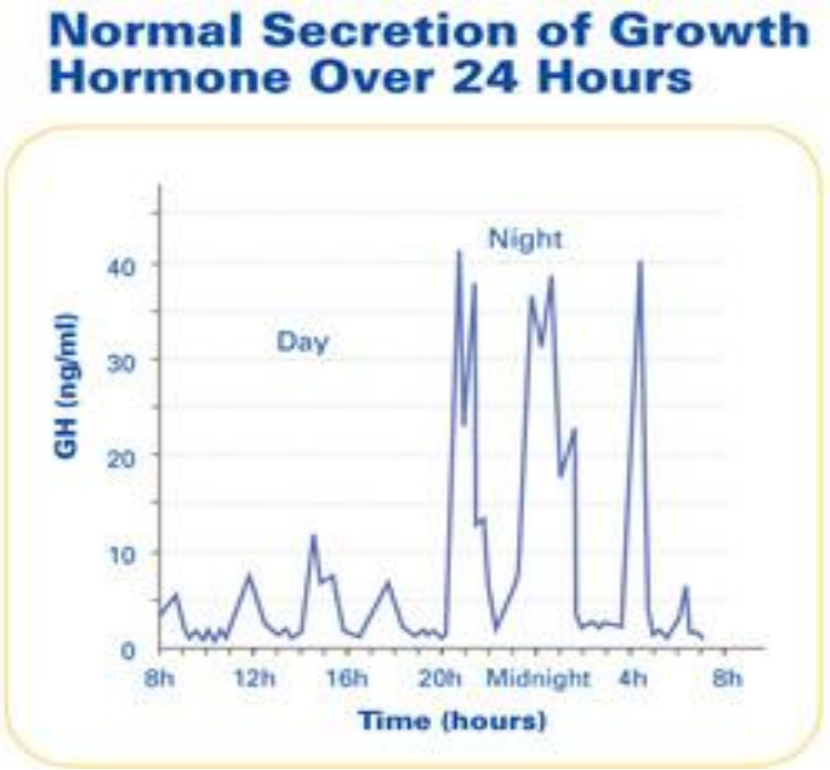
Negative Feedback

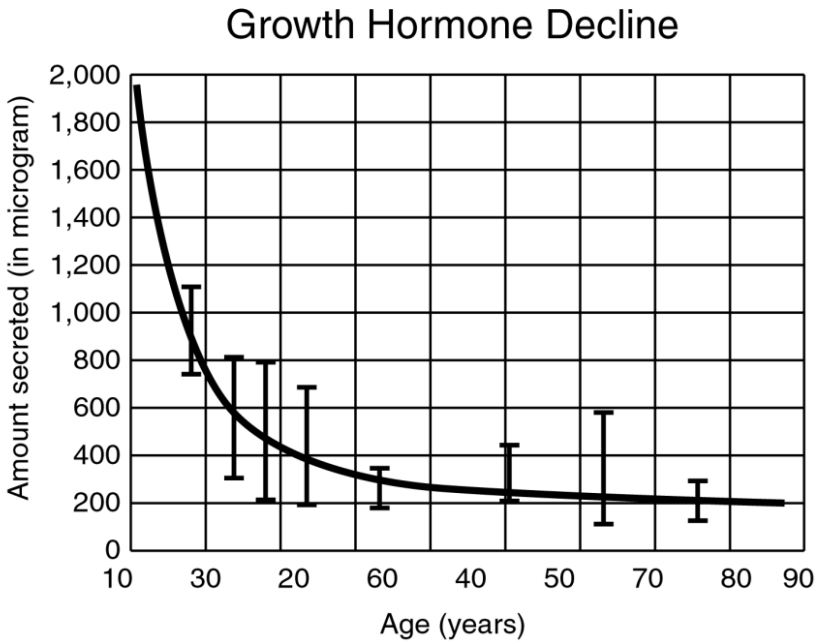


- High levels of IGF-1
  - Stimulates GHIH/SS
  - decreased secretion of GH
- High levels of GH
  - inhibits GHRH

GH Secretion

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





Increasing GH Production

- 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

http://www.achondroplasia.co.uk/achon.htm

Disproportionate Dwarfism: Achondroplasia

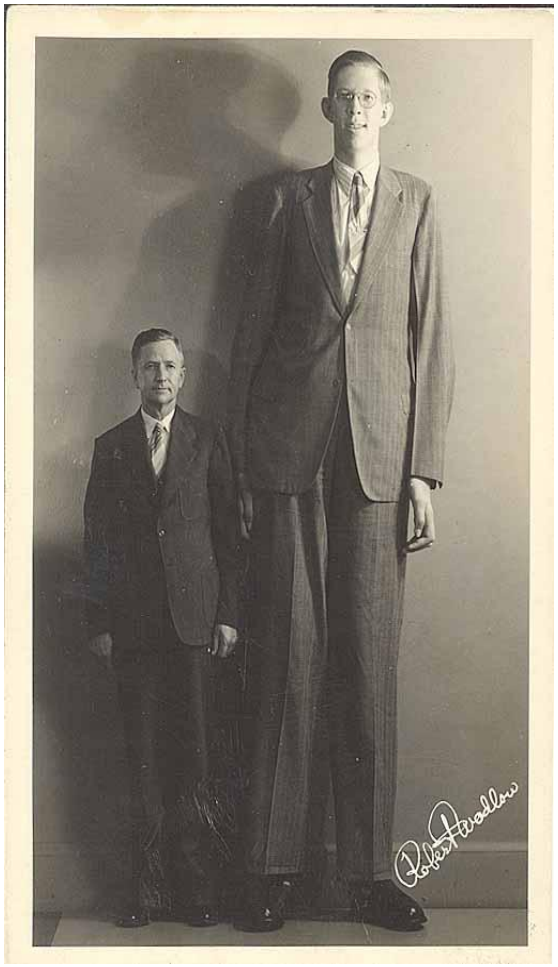
- most common type of dwarfism (70%)
- autosomal dominant
- mutation on chromosome 4
- caused by a gene mutation that affects **long bone** growth

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

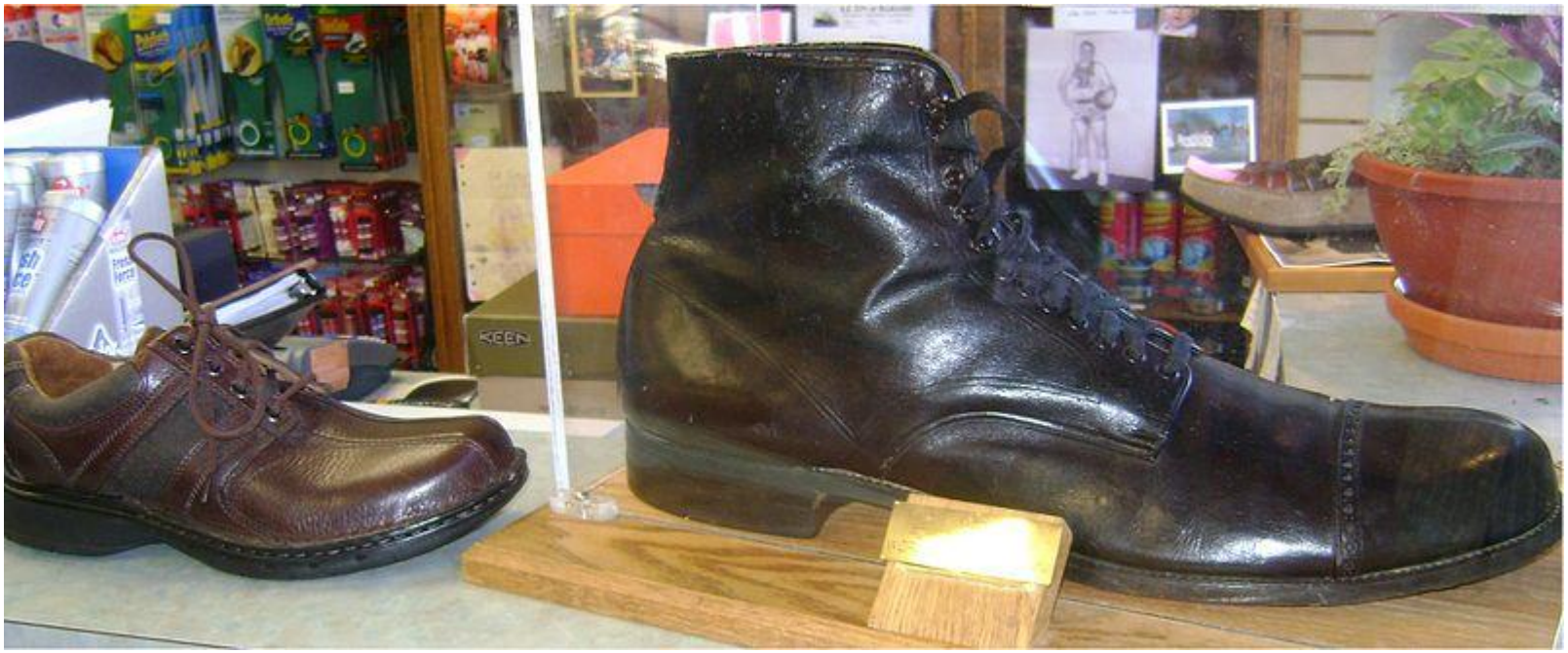


World's Tallest Man: Robert Wadlow (1918-1940)

8 feet 11 inches and 439 pounds when he died

http://www.alton-web.com/history/wadlow/#chart

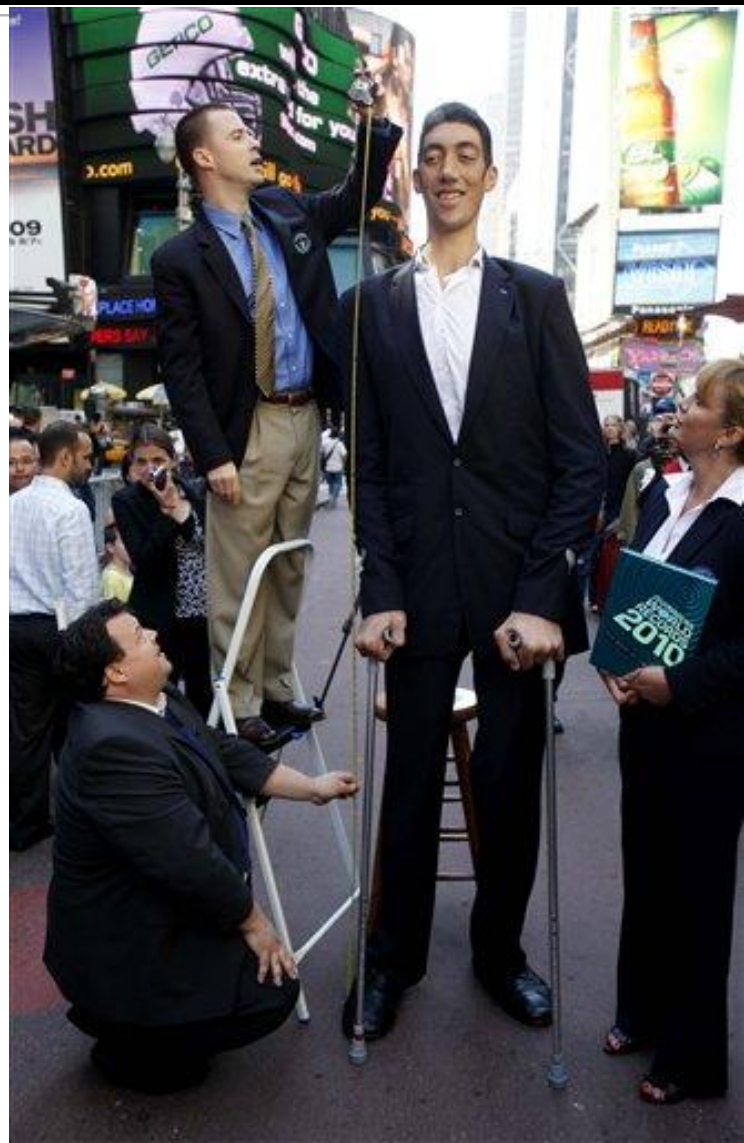
Size 12 Size 25



Tallest person alive

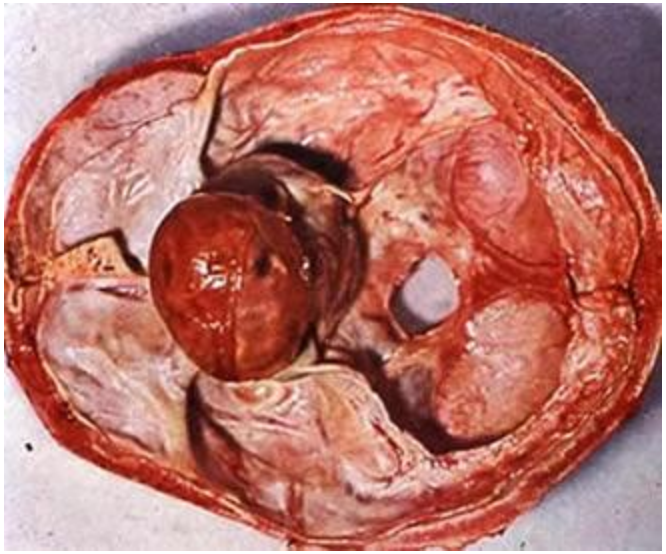
- Sultan Kosen
- born in Turkey
- 8 feet 1 inch

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

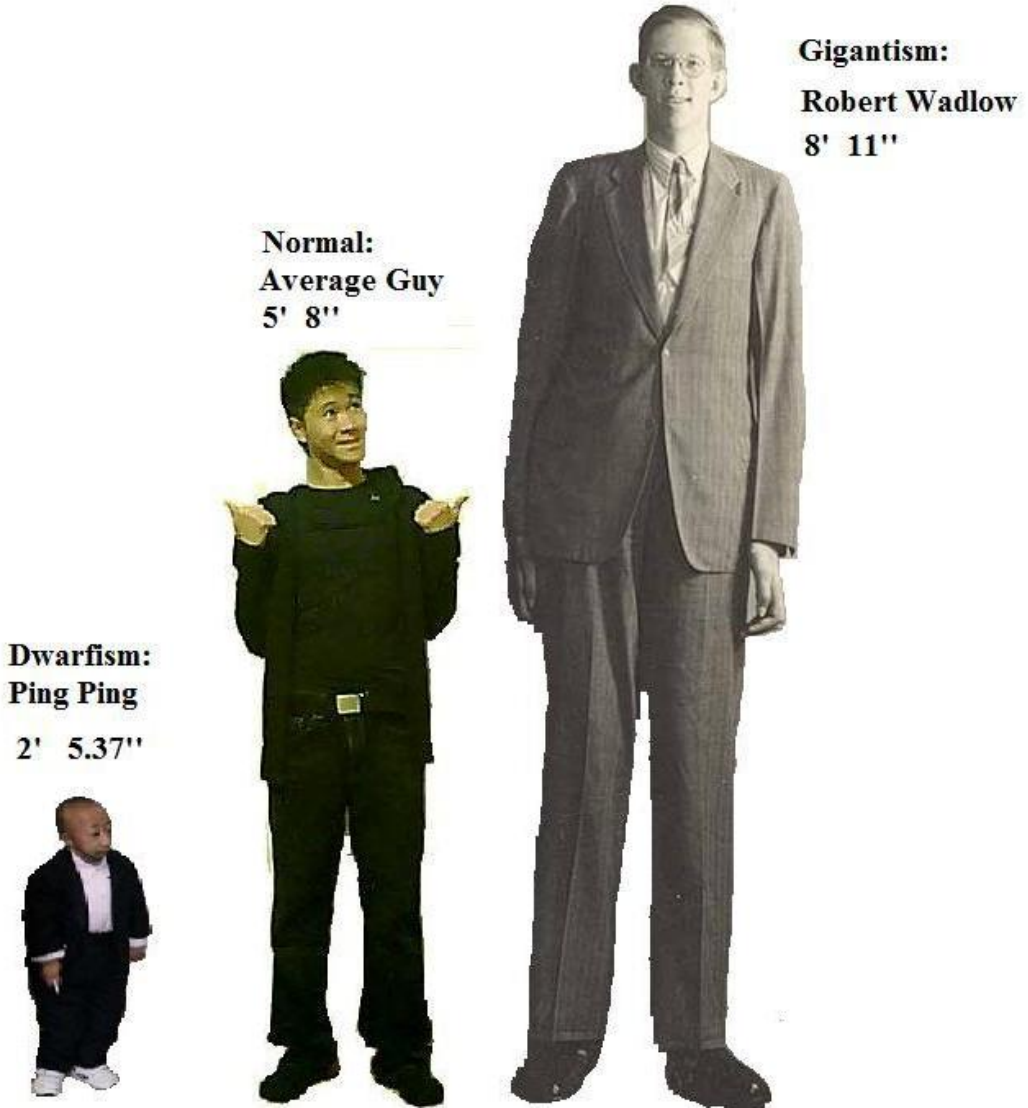


Gigantism Problems

- 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

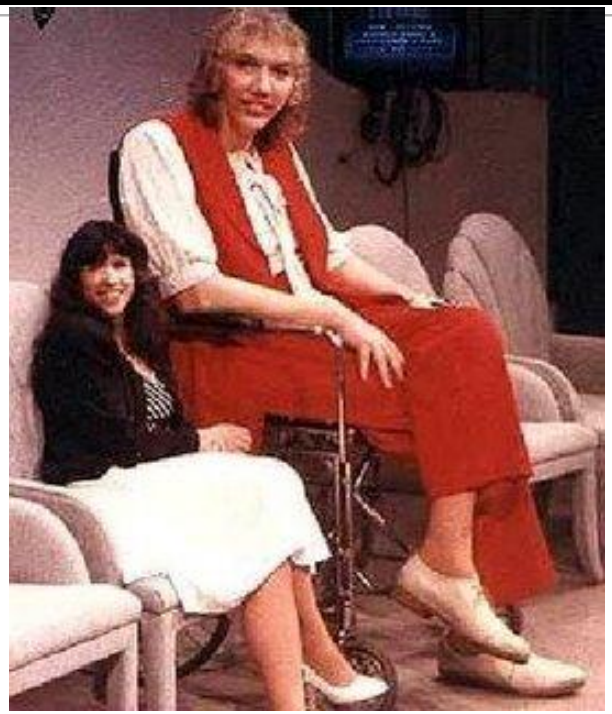
http://www.youtube.com/watch?v=5CdpIDdLSRs

Comparing Growths

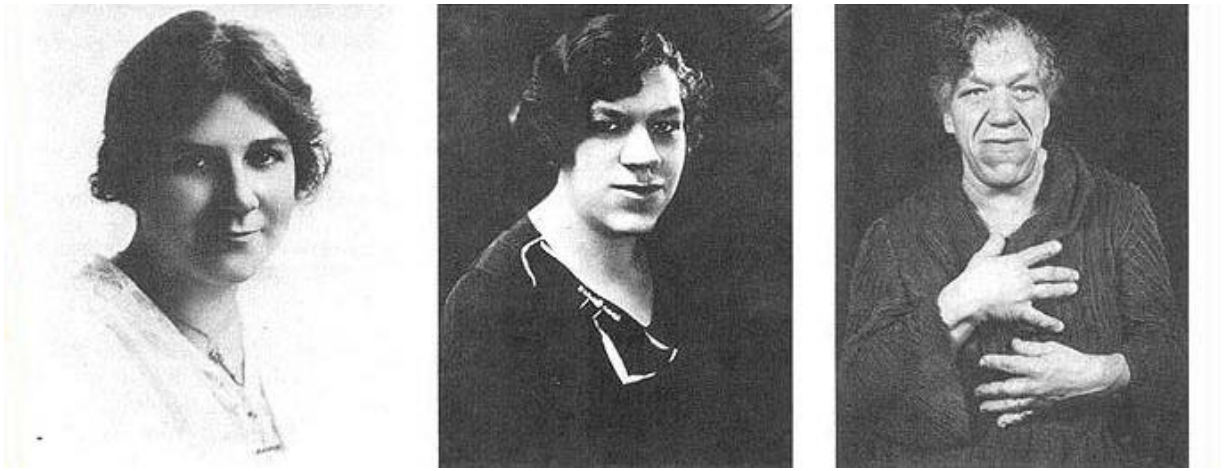


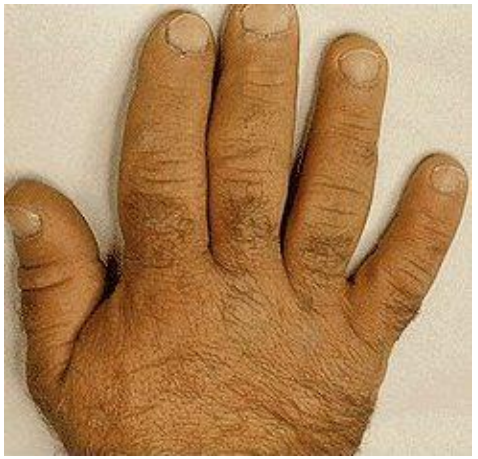
Acromegaly – Lateral Growth

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



Acromegaly: Physical Effects





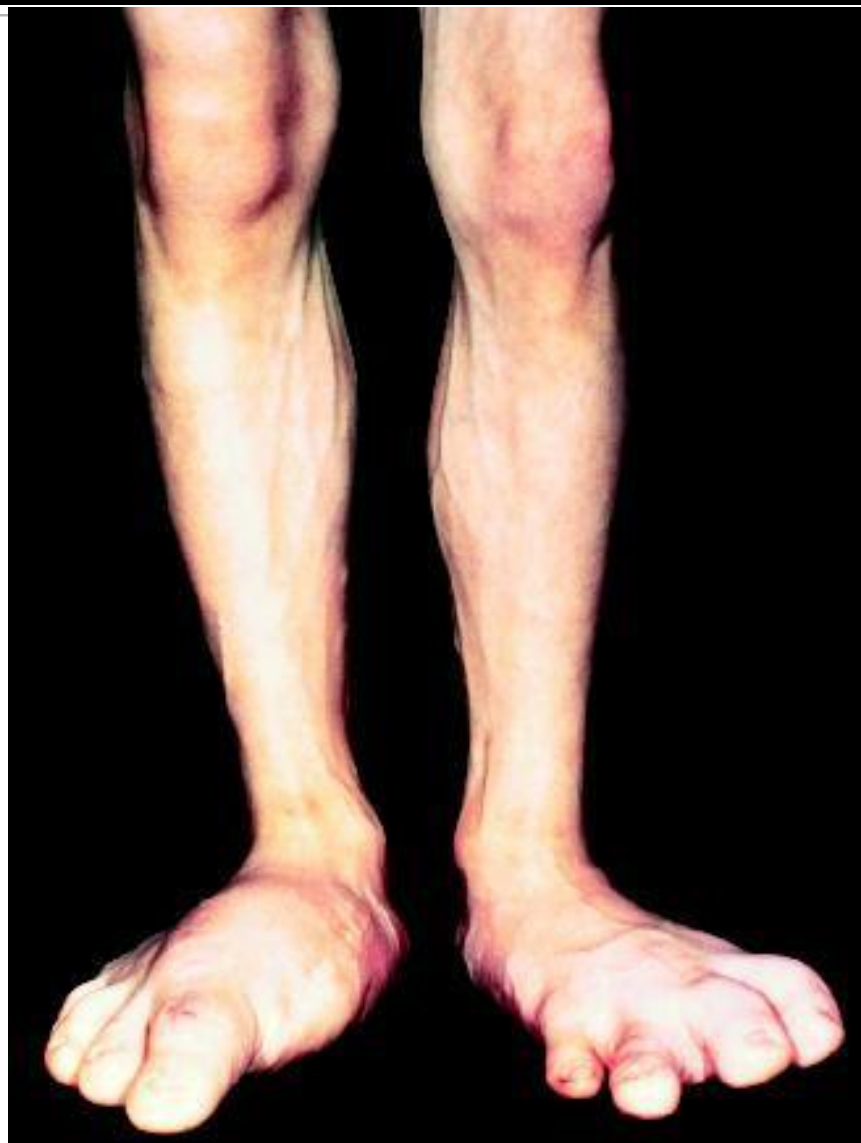
- Bone thickens
  - Forehead expands
  - Eyebrow ridges bulge outwards
  - Cheekbones more prominent
  - Bottom jaw enlarges and pushes lower teeth outwards and become widely space

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