College of science , Biology Department .

Animal physiology, endocrine Physiology.

Dr. Sanaa Jameel Thamer

# The Endocrine System

- Eendocrine system (ES) and homeostasis
- Anatomy:

1. Endocrine glands, cells, neurosecretory cells
2. Hormones: mechanical compounds carry message to target cells
3. Target cells

1. ES as a Control System

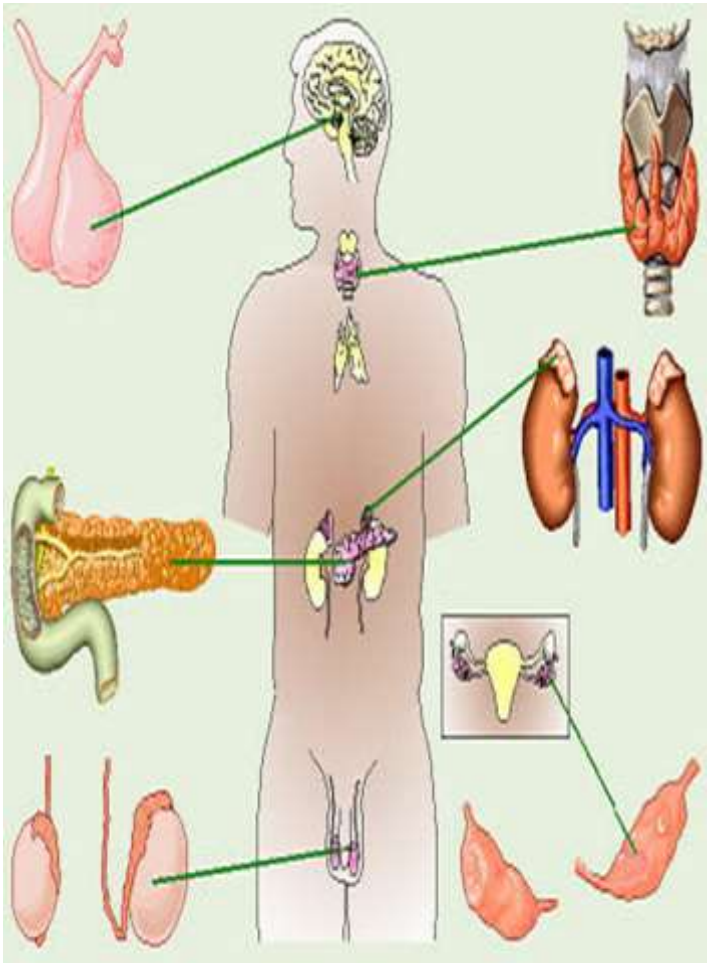
– Hormone + target = change in cell function (return to homeostasis).

Feedback Mechanisms:

1. Stimulus
2. change in homeostatic environment
3. signal sent to CNS (central nervous system)
4. Response
5. signal sent from CNS
6. produce effect
7. body returns to homeostasis.

ES and NS = 2 main control systems of body:

1. Endocrine organs located throughout body
2. Actions mediate all tissues
3. Control of ES through feedback mechanisms.



•Exocrine gland: Ducts, Lumen and surfaces.

•Endocrine gland : Chemical messengers, Blood stream.

Hormones: Chemical messenger Secreted by endocrine gland , Specific to target, Activate cellular change

And have different chemical types: Peptide/ Protein, Steroid, Amine, Eicosanoid.

Types of hormones:

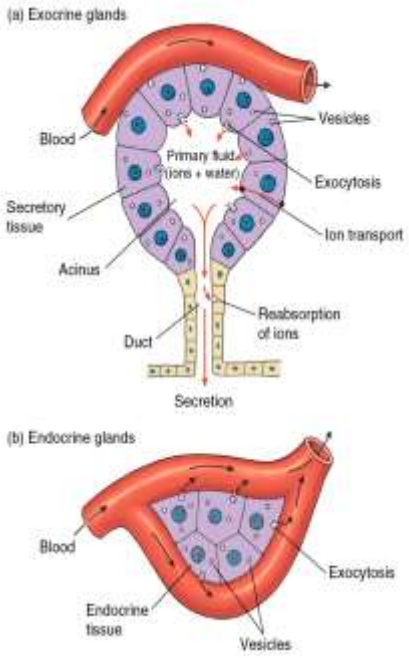
•Peptide/ Protein: Hydrophilic, Large, Can't fit through membrane, Second messenger mechanism of action

Most hormones , Example: Insulin/ glucagon.

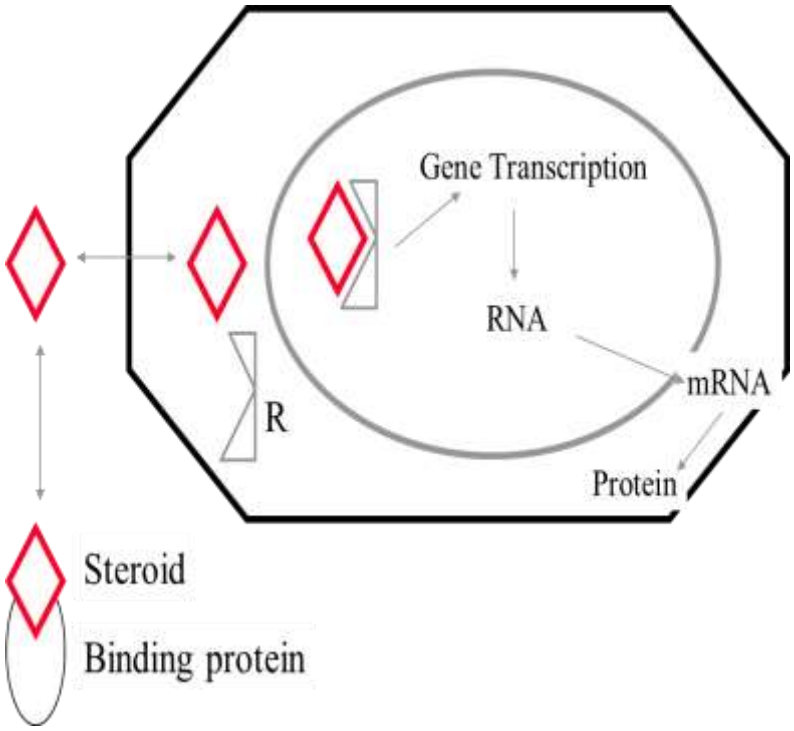
•Steroid: Small , Hydrophobic/Lipophilic, Travel in blood with carrier, Cytoplasmic or nuclear receptors ,change protein synthesis , Genomic effect (Activates genes) Directs synthesis of new proteins, Example: estradiol.

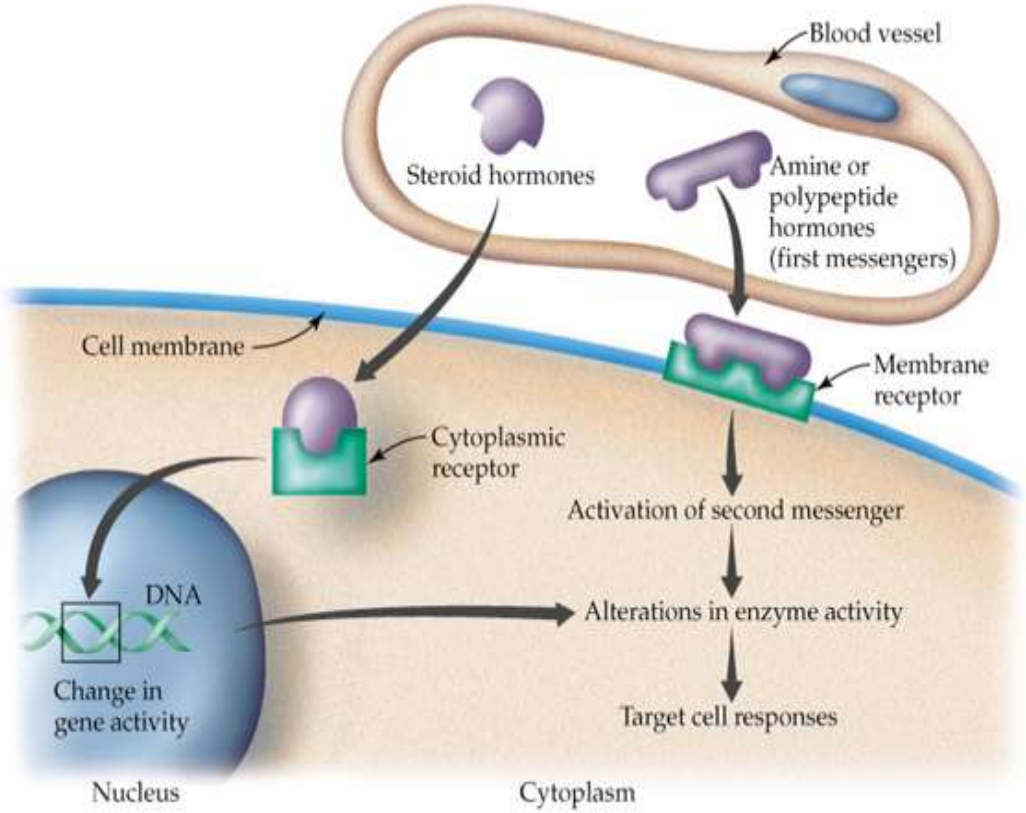
• Amine: Synthesized from a single amino acid, Melatonin from tryptophan , Thyroid hormone from tyrosine, Catecholamines (EPI) from tyrosine.

•Eicosanoid: Produced from 20-carbon fatty acid, arachidonic acid, Produced in all cells except RBCs, Prostaglandins and leukotrienes .

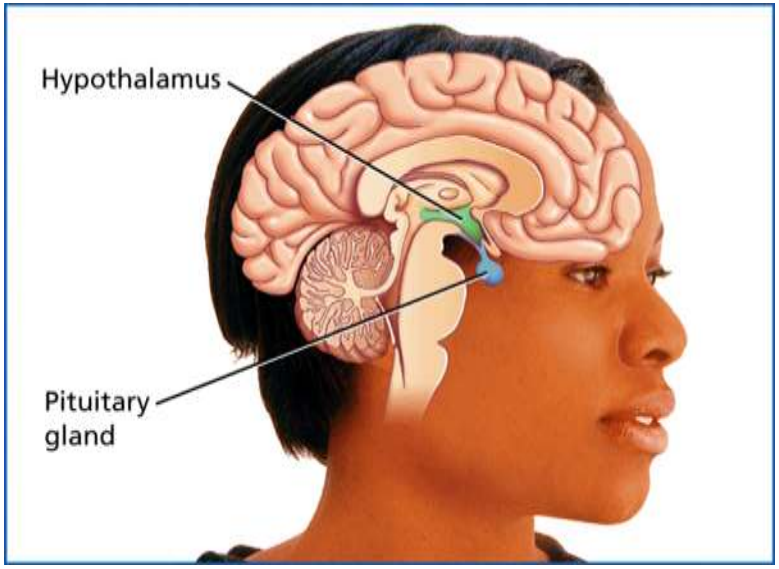


| | Peptide Hormones | Steroids |
|---|---|---|
| Half-life in circulation | short | long |
| Speed of action | fast | slow |
| Duration of effect | short | long |
| Location of receptor | membrane | inside |
| Post-receptor regulation | high | low |
| Signal amplification | high | low |



# Hypothalamic-Pituitary Axis ( HPA)




•Most feedback loops run through this axis

•HPA mediates growth, metabolism, stress response, reproduction.

Hypothalamus : Connection to pituitary:

•Neuronal to POSTERIOR PITUITARY (Neurosecretory Cells).

•Endocrine to ANTERIOR PITUITARY.

Neurosecretory Cells: Specialized neurons, Synthesize and secrete hormones, Extend from HYPOTHALAMUS to POSTERIOR PITUITARY (Neuronal connection), Antidiuretic Hormone (ADH), Oxytocin.

Why is the Hypothalamus so Important?

Secretes regulatory hormones, RH, RIH ( "Directs" pituitary).

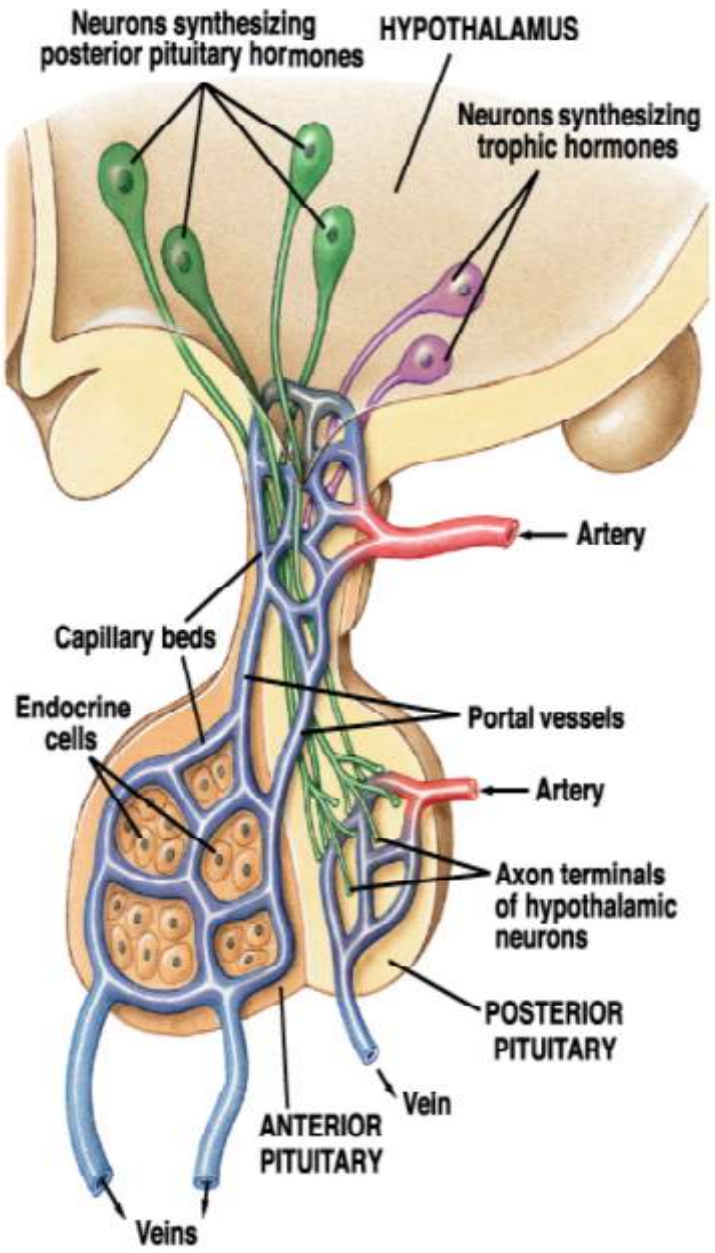
•RH = Pituitary releasing hormones (Thyrotropin releasing hormone-TRH), Growth hormone releasing hormone-GHRH.

•RIH = Pituitary release inhibiting hormones (Somatostatin Prolactin release inhibiting hormone-PIH).

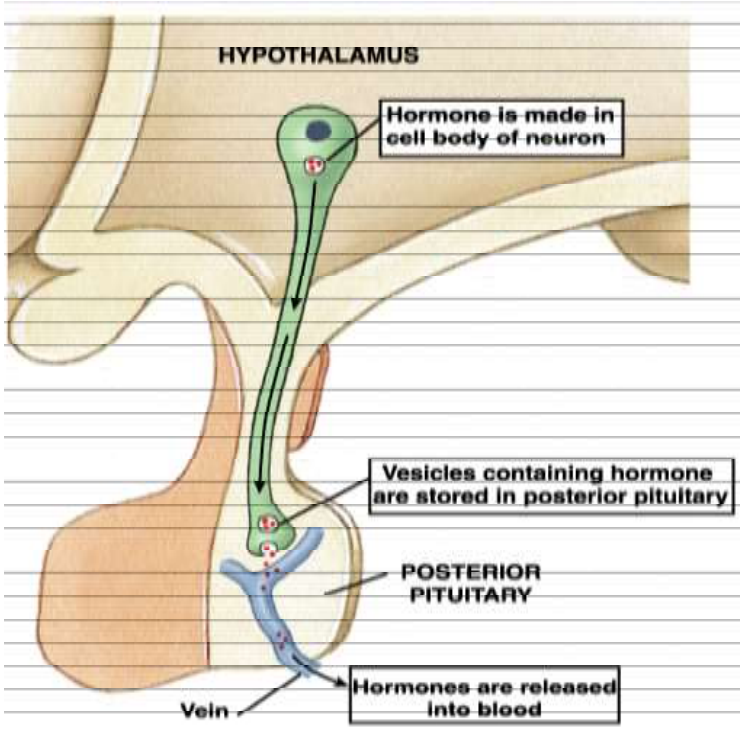
STIMULUS ⟶ hypothalamus (RH,RIH)⟶ pituitary stimulating hormone⟶ gland hormone⟶ target

# Hypothalamic releasing hormones

| Hypothalamic releasing hormone | Effect on pituitary |
|---|---|
| Corticotropin releasing hormone (CRH) | Stimulates ACTH secretion |
| Thyrotropin releasing hormone (TRH) | Stimulates TSH and Prolactin secretion |
| Growth hormone releasing hormone (GHRH) | Stimulates GH secretion |
| Somatostatin | Inhibits GH (and other hormone) secretion |
| Gonadotropin releasing hormone (GnRH) | Stimulates LH and FSH secretion |
| Prolactin releasing hormone (PRH) | Stimulates PRL secretion |
| Prolactin inhibiting hormone (dopamine) | Inhibits PRL secretion |



# Pituitary gland


MASTER GLAND: Anterior and posterior portions
Posterior connected to hypothalamus by infundibulum,
Anterior connected via blood stream.
•Posterior Pituitary (Post. Pit) Hormones: Manufactured in Hypothalamus, released from Post. Pit. Oxytocin: Target = smooth ms. Uterus and Breast (&brain) ,Function = labor and delivery, milk ejection.
ADH (Vasopressin AVP) ,Target = kidneys, Function = water reabsorption.
• anterior pituitary produces six peptide hormones:
prolactin, growth hormone (GH), thyroid stimulating hormone (TSH), adrenocorticotropic hormone (ACTH), follicle-stimulating hormone (FSH), luteinizing hormone (LH).

| HORMONE | TARGET | FUNCTION |
|---|---|---|
| Thyroid (TSH) Stimulating | Thyroid gland | TH synthesis & release |
| Growth (GH) | Many tissues | growth |
| Adrenocortico-Tropin (ACTH) | Adrenal cortex | Cortisol release (androgens) |
| Prolactin (Prl) | Breast | Milk production |
| Follicle (FSH) | Gonads | Egg/sperm prod. |
| Luteinizing (LH) | Gonads | Sex hormones |

# Control of Endocrine Function

1. Positive Feedback mechanisms.
2. Negative Feedback mechanisms.
3. Self-regulating system.

•Positive Feedback mechanisms:

Not common, Classic example:

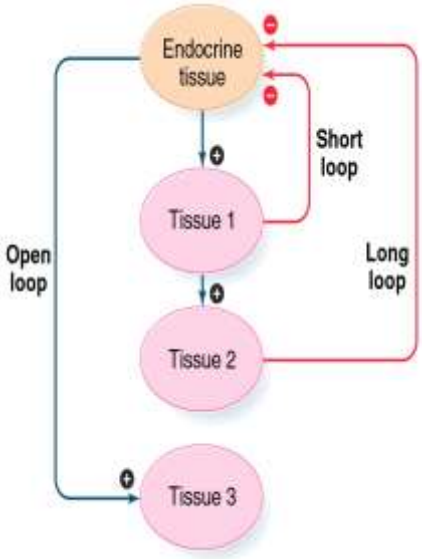
action of OXYTOCIN on uterine muscle during birth.

•Negative Feedback mechanisms:

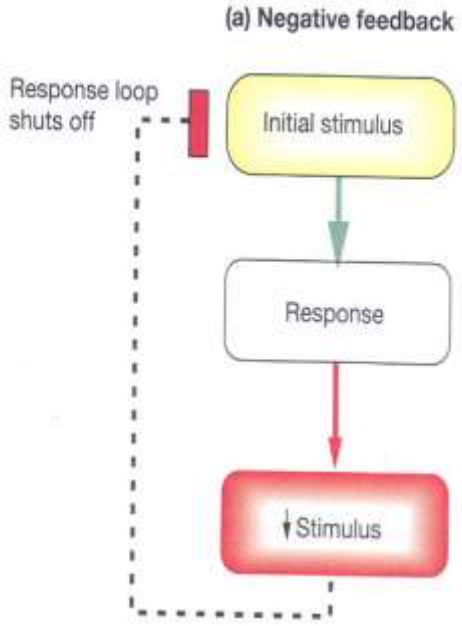
Most common control mechanism

1. Structure of Feedback Loop :
2. Basic Environmental Stimulus.
3. Stimulates Control Center (Brain-hypothal).
4. Hypothalamic hormones stim. Pituitary.
5. Pituitary hormone stim. Target area.
6. Target area produces change.
7. Change acts negatively or positively on the cycle.

Specific Endocrine Events: Thyroid Hormone, Growth Hormone, Adrenal Cortex Hormones, Sex Steroids




STIMULUS
↓
hypothalamus
(RH,RIH)
↓
pituitary SH
↓
gland hormone
↓
target



# A. Thyroid Hormone

1. ↓ T3 & T4 stim. Or environmental stim. Hypothalamus
2. TRH stim. Anterior Pituitary
3. TSH stim. Thyroid
4. ↑ T3 & T4 shuts off TRH and TSH production.

Explain:

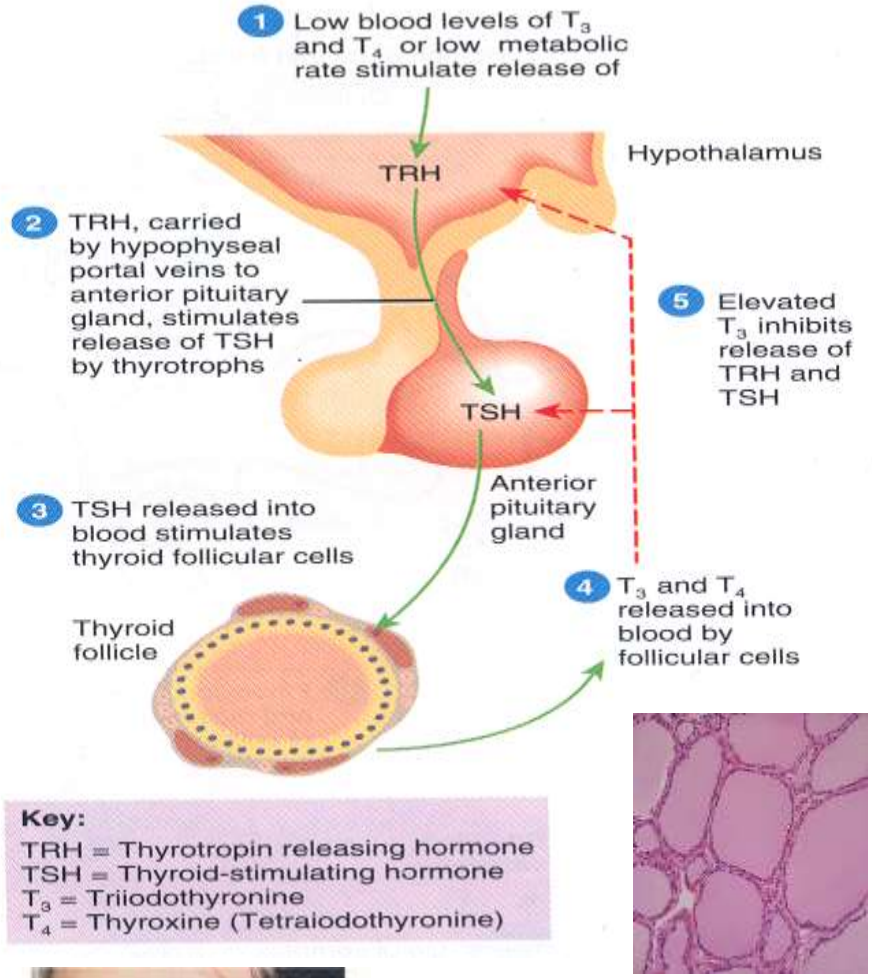
•Low levels of T3 or T4 in blood stimulus

•Hypothalamus releases TRH that stimulates the ANTERIOR PITUITARY to release TSH which stimulate Thyroid to release T3 & T4. Levels of T3 & T4 shut off Hypothal. & Anterior Pituitary.

What would happen if the thyroid could no longer produce T3 and T4?

Goiter :

1. Hyper secretion of TSH or TH,
2. Hypo secretion of TH ,
3. No negative feedback to hypothalamus and anterior pituitary.






# B. Growth Hormone

- Stimulus = Tissue growth/ repair
- Hypothalamus releases GHRH
- Anterior Pituitary releases GH
- ↑ Protein synthesis, growth, etc.
- ↑GH and release of somatostatin shuts off GHRH and GH release

↑GH as an Adult


↑GH as Juvenile

↓GH = pituitary dwarfism

# Adrenal Gland

•Adrenal gland located at top of kidney

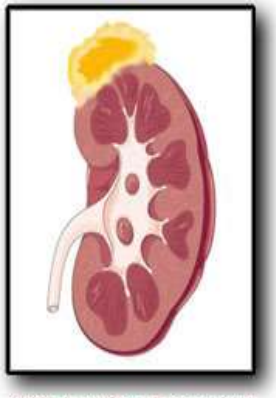
•Outer part = cortex : Secretes :Cortisol (stress), Androgens, Aldosterone (electrolytes)

•Inner part = medulla : Secretes EPI & NEPI (fight or flight).

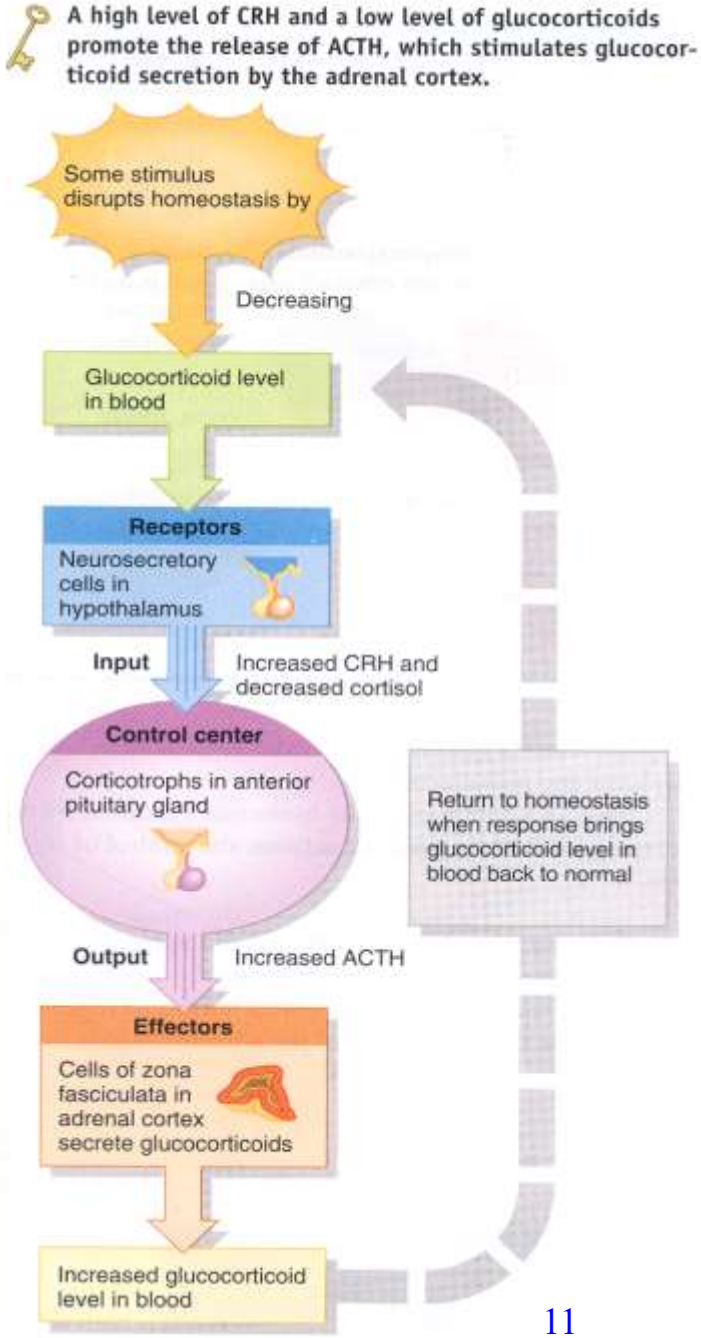
Adrenal cortex feedback

1. Low glucocorticoid (cortisol) levels or low blood sugar
2. Stim. Hypothal. = CRH
3. CRH stim. Anterior Pit. = ACTH
4. ACTH stim. Adrenal Cortex.
5. Increase glucocort. Level then blood sugar level.

– Adrenal Insufficiency:
– Addison's disease--hyposecretion of cortisol.
– Darkened skin (ACTH mimics MSH melanocyte stimulating hormone )
– Weight loss, hypoglycemia



Click here for a larger view



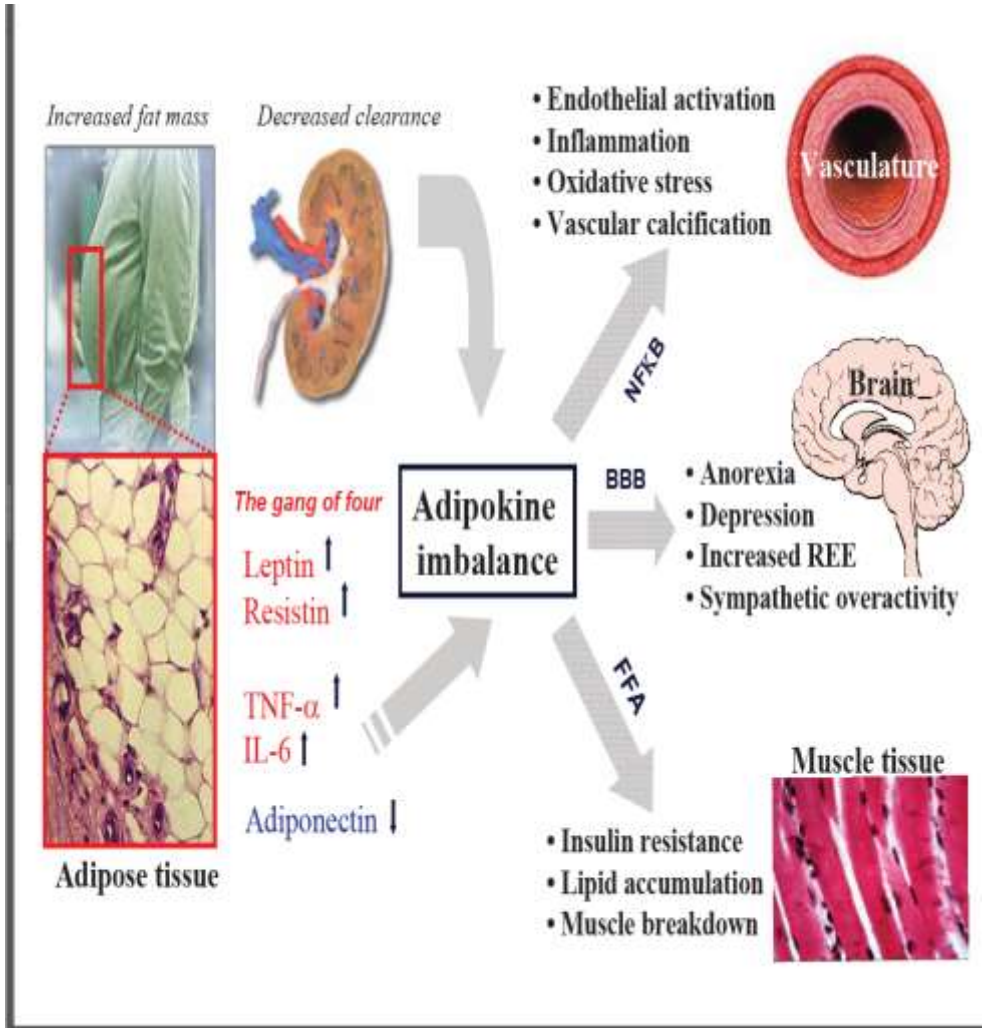
- Sex Steroids: Stimulus = low circulating Testosterone or Estrogen

1. Hypothalamus = GnRH
2. Anterior Pituitary = FSH & LH
3. Gonads produce T : testesteron and E:estrogen
4. High T and E shut off GnRH and FSH/LH.

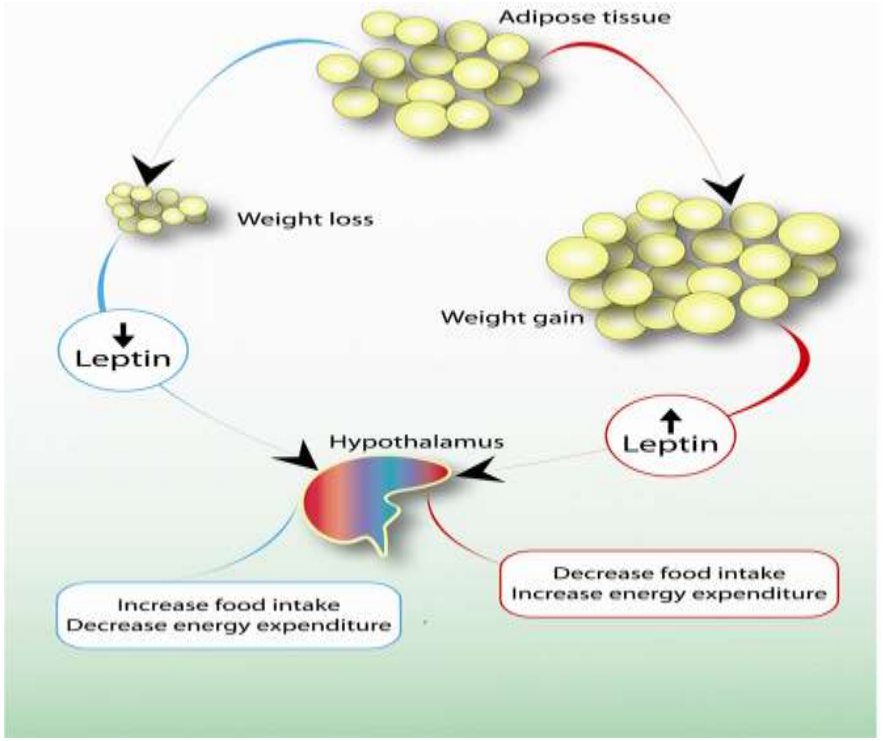
Adipose tissue:

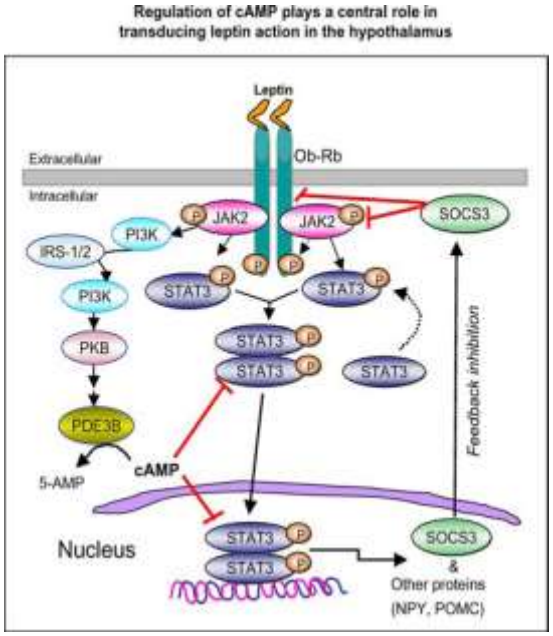
- Largest repository of energy in the body , storage Triglycerides ,9.3kcal/g
- Contributes to thermal insulation , Important for temperature regulation, Fills spaces between structures/protects Between organs, Aids fit of valves in heart.
- Secretions:

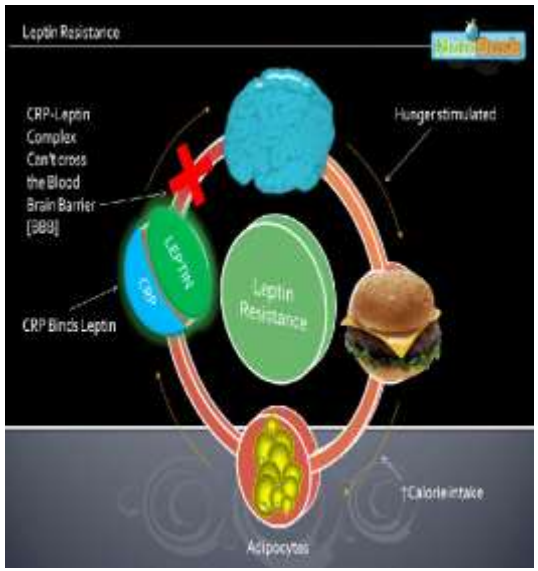
1. Fat-derived peptides – "Adipokines"
2. TNF-alpha – impairs insulin signaling pathways / suppresses adipocyte differentiation
3. Leptin – enhances insulin action / anorexigenic
4. Resistin – Known to be elevated in obesity / IR
5. – Adiponectin - enhances insulin action / glucose clearance / fatty acid oxidation
6. IL-1/ IL-6 –



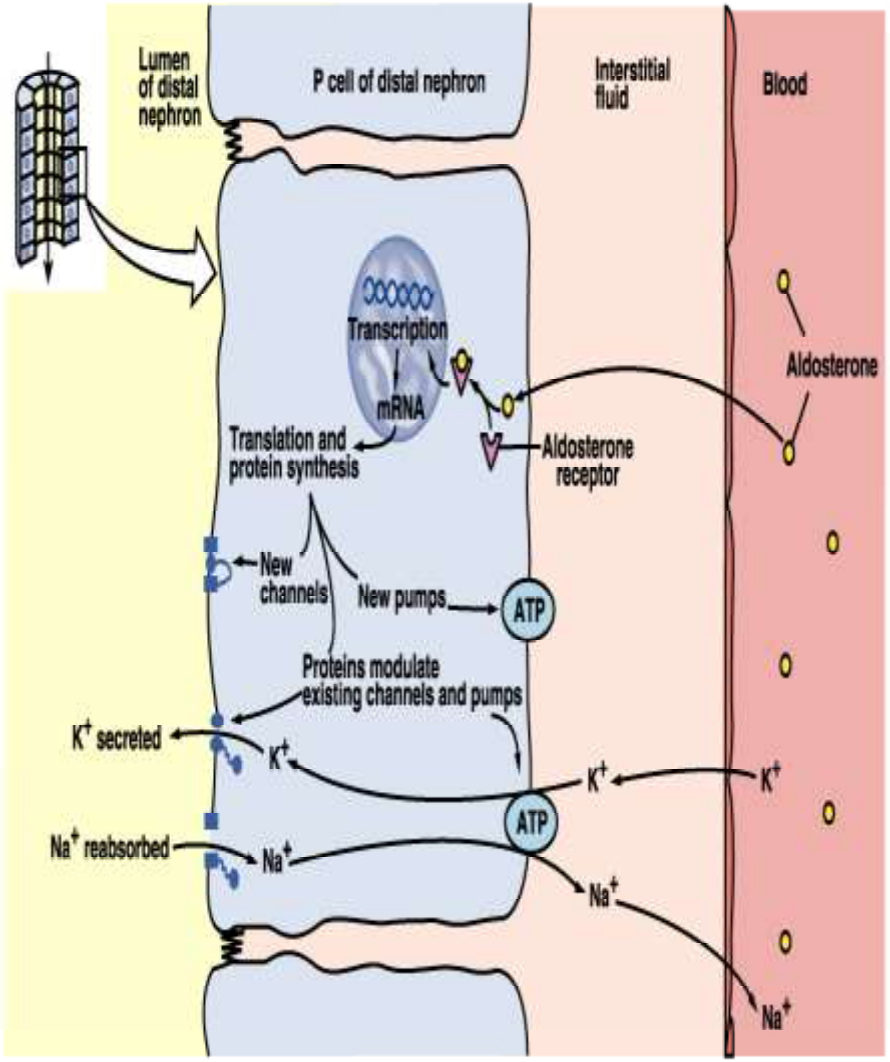
- mutant strain of obese mice (ob/ob) they characterized by severe obesity which increasing food intake and decreased physical activity.
- Leptin is protein hormone contain 167 amino acid in humans .
- the leptin resistance is caused by hyper activity of suppressors of cytokine signaling3 (SOCS-3) which can inhibit intracellular leptin signal transduction pathway.

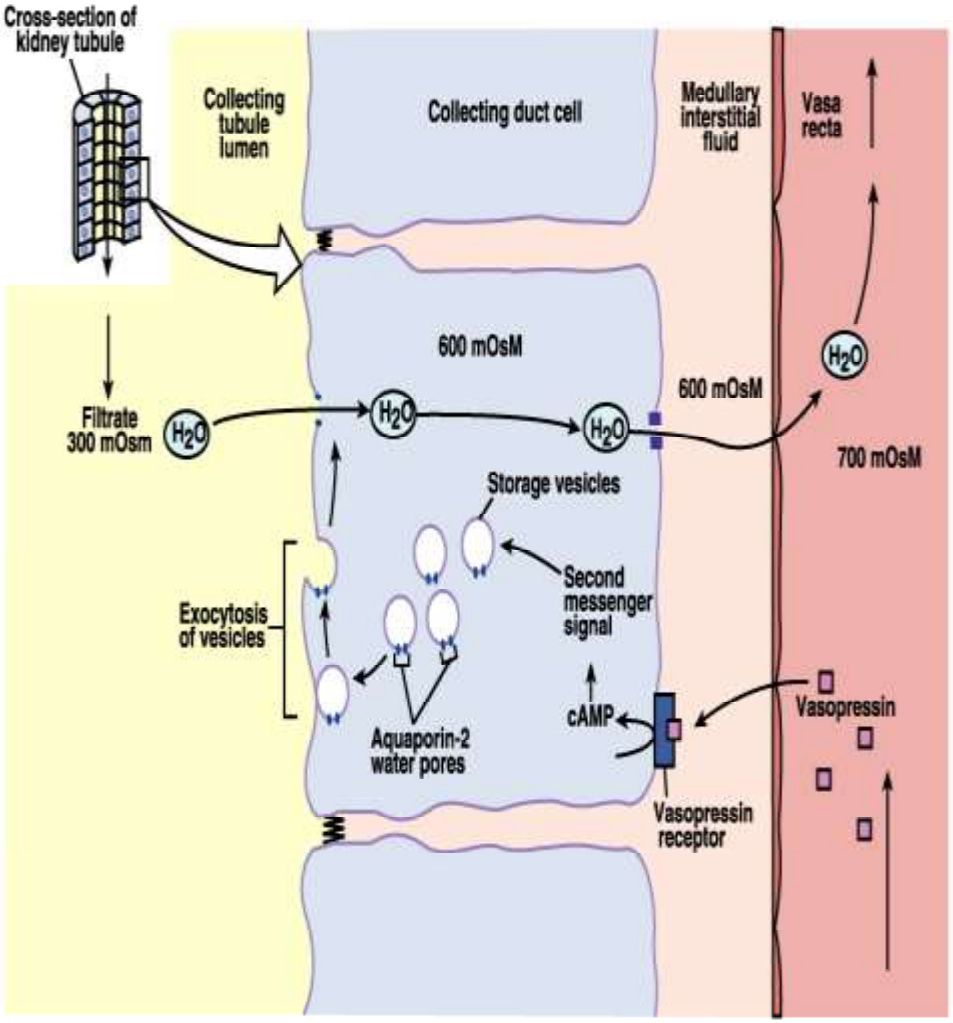



The control of aldosterone; it increases Na+ reabsorption into the blood from the kidney filtrate




Influence of ADH on the Collecting Ducts