



# Lecture 10. Hormones control of the homeostasis. Hormonal control in adaptation response regulation of the organism

# Hormones of pancreas

- **Insulin.** Chemical structure: protein

## ***Effect of insulin on carbohydrate metabolism:***

- increases the permeability of cell membranes of skeletal muscles, adipose tissue and liver for glucose;
- activates the first enzyme of glycolysis - glucokinase and prevent the inactivation of hexokinase;
- activates some enzymes of Krebs cycle (citrate synthase);
- activates the pentose phosphate cycle;
- activates glycogen synthetase;
- activates pyruvate dehydrogenase and  $\alpha$ -ketoglutarate dehydrogenase;
- inhibits the gluconeogenesis;
- inhibits the decomposition of glycogen.

### ***Effect of insulin on protein metabolism:***

- increases the permeability of cell membranes for amino acids;
- activates synthesis of proteins and nucleic acids;
- inhibits the gluconeogenesis.

### ***Effect of insulin on lipid metabolism:***

- enhances the synthesis of lipids;
- promotes the lipid storage activating the carbohydrate decomposition;
- inhibits the gluconeogenesis.

### ***Effect of insulin on mineral metabolism:***

- activates  $\text{Na}^+$ ,  $\text{K}^+$ -ATP-ase (transition of K into the cells and Na from the cells).

***The deficiency of insulin causes diabetes mellitus.***



## ***Glucagon.***

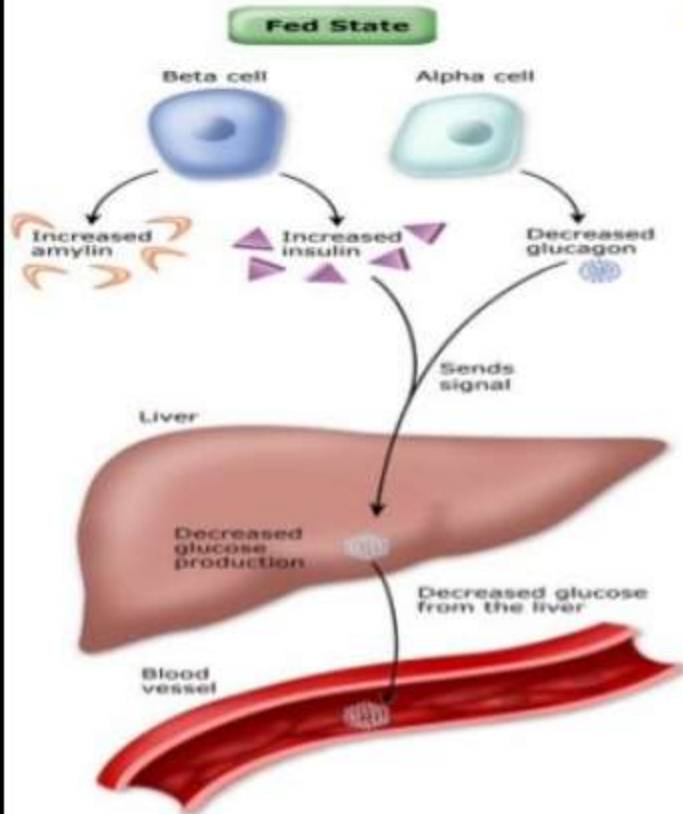
Chemical structure: polipeptide

### **Functions:**

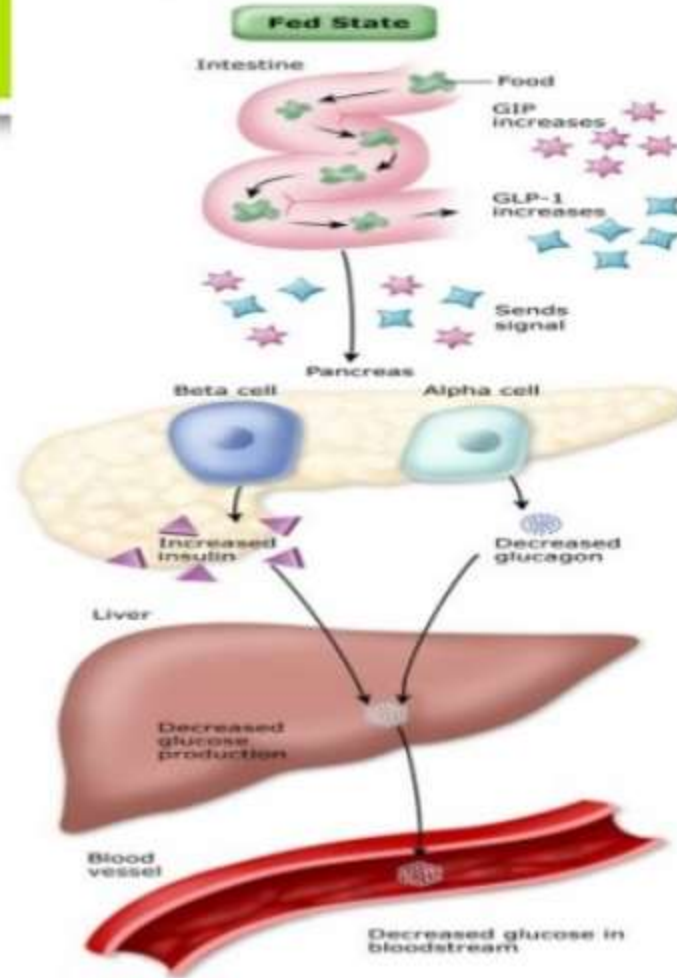
- enhances the glycogen splitting in liver;
- activates the lipolysis;
- stimulates the gluconeogenesis.

| <b>hormone</b>             | <b>tissue of origin</b>       | <b>effect on blood glucose</b> |
|----------------------------|-------------------------------|--------------------------------|
| <b>insulin</b>             | <b>pancreatic beta cells</b>  | <b>lowers</b>                  |
| <b>somatostatin</b>        | <b>pancreatic gamma cells</b> | <b>lowers</b>                  |
| <b>glucagon</b>            | <b>pancreatic alpha cells</b> | <b>raises</b>                  |
| <b>epinephrine</b>         | <b>adrenal medulla</b>        | <b>raises</b>                  |
| <b>cortisol</b>            | <b>adrenal cortex</b>         | <b>raises</b>                  |
| <b>ACTH+Growth hormone</b> | <b>anterior pituitary</b>     | <b>raises</b>                  |

### The Effect of Amylin



### The Effect of GLP-1 and GIP



# Target Blood Sugar Levels for Diabetes

## Age 20+

Fasting less than **100**

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Before Meal **70-130**

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After Meal (1-2hrs) less than **180**

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Before Exercise if taking insulin,  
at least **100**

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Bedtime **100-140**

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Amounts shown above **mg/dL**

A1c less than  
or around **7.0%**



### ***Somatostatine.***

Somatostatine is produced by hypothalamus, intestine and  $\delta$ -cells of pancreas).

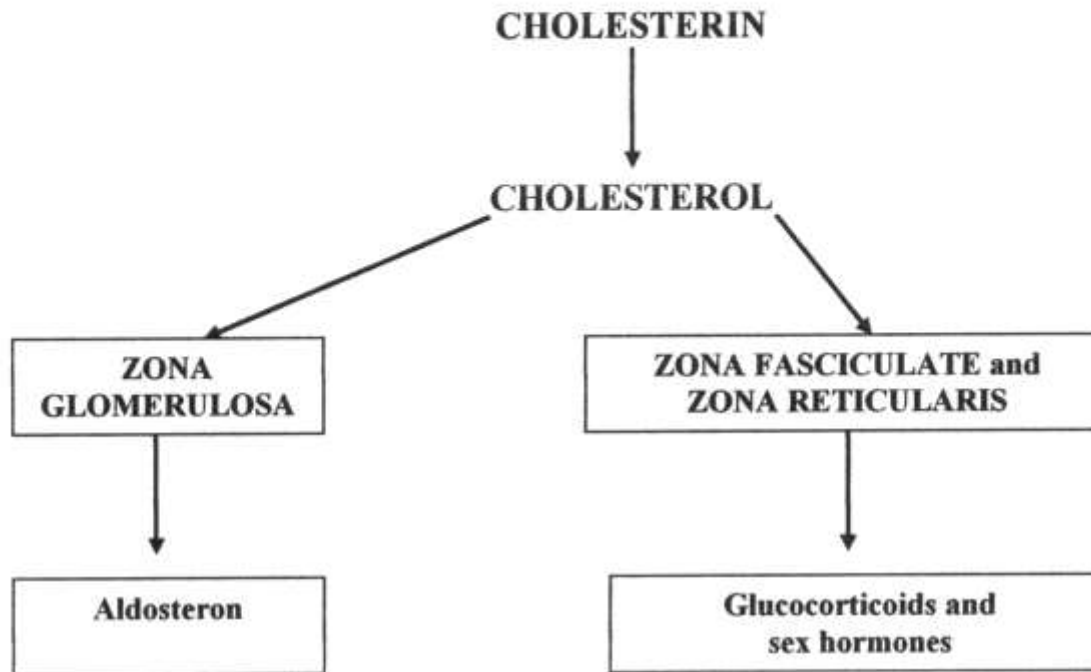
- Functions:
- inhibits the secretion of insulin and glucagon;
- inhibits secretion of somatotropic and thyrotropic hormones;
- inhibits secretion of tissue hormones of alimentary tract.

### ***Lipocain.***

Lipocain is produced in the epithelium cells of pancreatic ducts.

- Functions:
- activates the formation of phospholipids in liver and stimulates the action of lipotropic alimentary factors;
- activates the oxidation of fatty acids in liver.

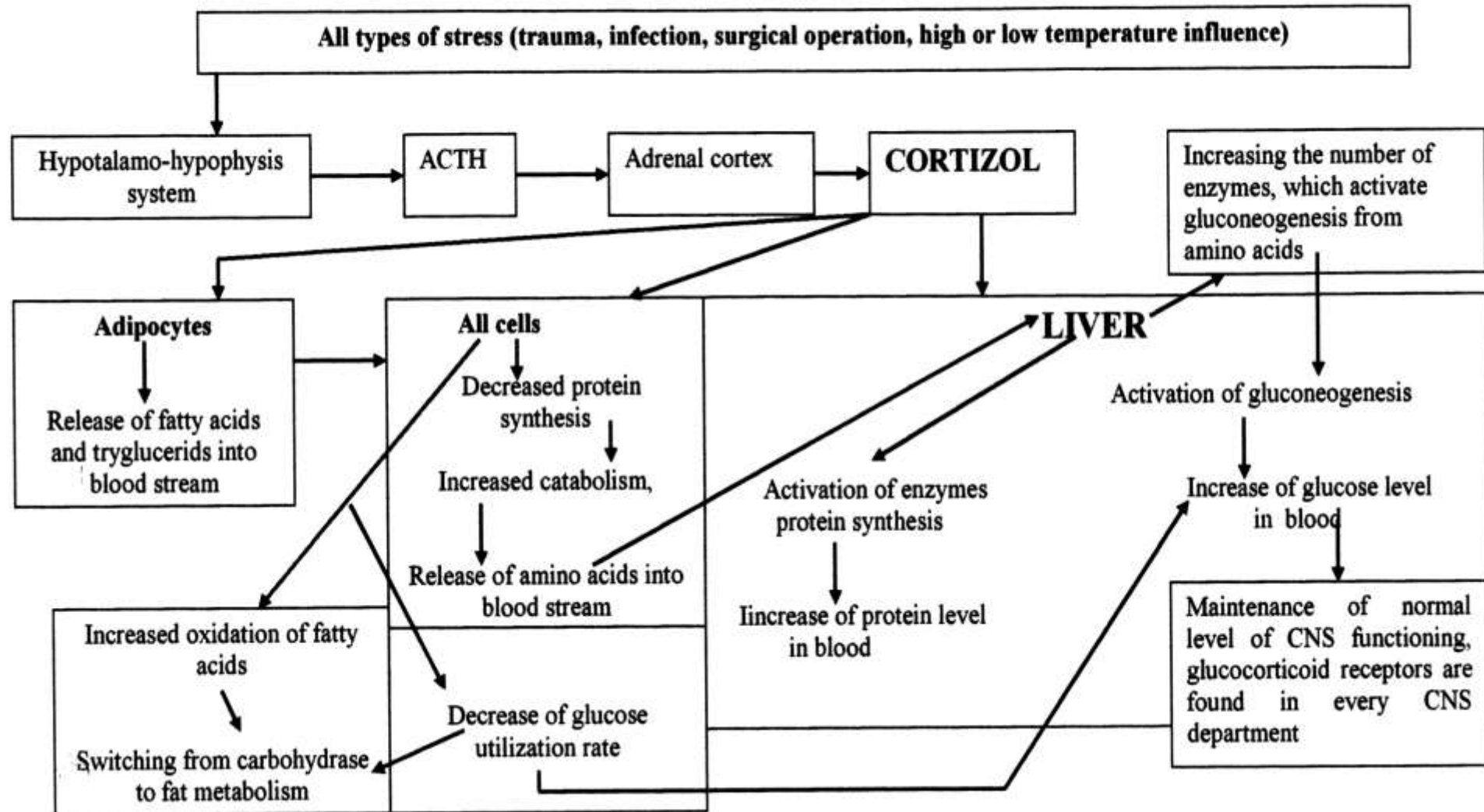
## CORTICOSTEROIDS SYNTHESIS AND MAIN EFFECTS



### Types of glucocorticoids influence

- Metabolic:
  - Gluconeogenesis from amino acids
  - Protein metabolism
  - Lipid metabolism
- Participation in stress reactions
- Anti-inflammatory action

## METABOLIC EFFECTS OF CORTICOSTEROIDS



## GLUCOCORTICOIDS ANTI-INFLAMMATORY INFLUENCE

### STAGES OF INFLAMMATION

1. Release of pro-inflammatory substances from damaged cells-histamine, bradikinin, proteolytic enzymes.
2. Increased blood supply at the site of inflammation
3. Oedema
4. Leukocyte infiltration
5. Increased temperature at the site of inflammation.

Stabilization of lysosomal membranes to prevent the release of biologically active pro-inflammatory substances

### CORTIZOL

Decreases leucocytes migration

Decrease capillary permeability to prevent leucocytes migration

Increases receptor sensitivity to noradrenalin, increases the number of  $\alpha$ -receptors (vessels constriction)

Inhibits serotonin, histamine and kinins secretion, inhibits complement system, blood clotting system and plasmin-fibrinolysin system

*Decreases immune system activity*

Thymus and lymphoid glands involution

Decreased T-lymphocytes activity

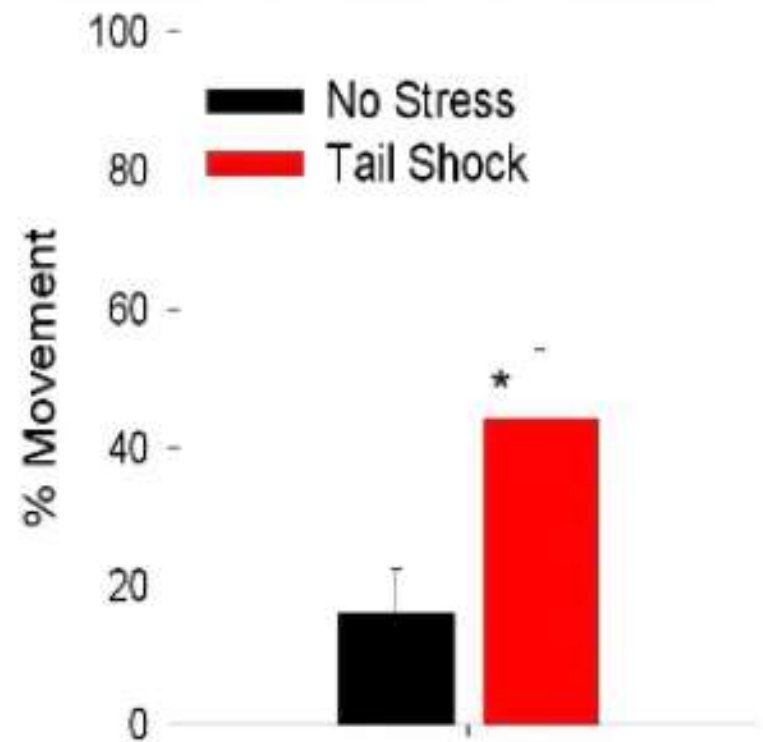
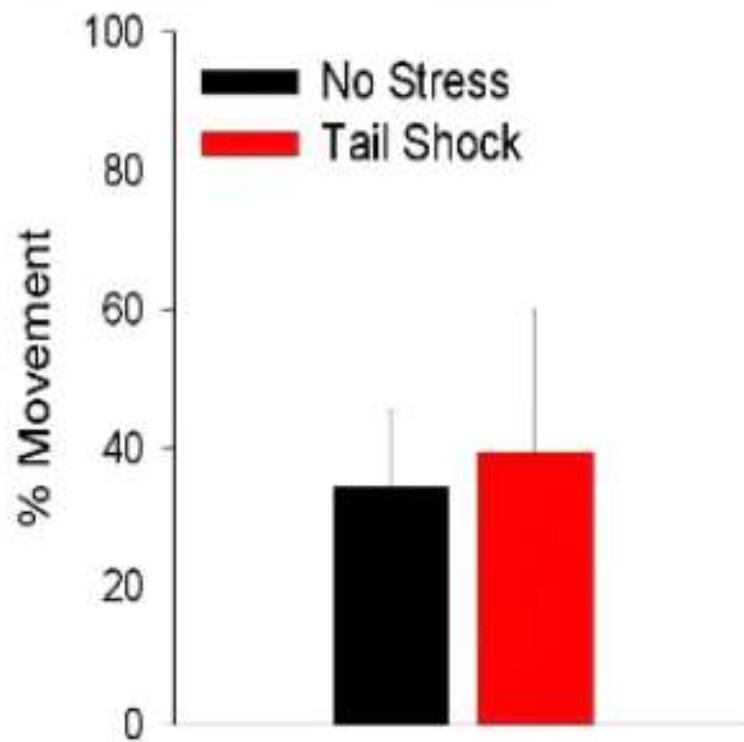
# Typical findings in Cushing's syndrome

- Caused by prolonged decrease in plasma corticoids
- Increased protein catabolism results in :
  - Thin skin
  - Poor muscle development
  - Poor wound healing
  - Bruisability with ecchymoses
  - Thin and scraggy hair

# Typical findings in Cushing's syndrome

- Redistribution of body fat : thin extremities, fat collects in the abdominal wall, face, upper back
- Purple striae (subdermal tissue rupture due to increased subcutaneous fat depots)
- osteoporosis





Townsend et al. 2004

RUTGERS

# Stress Hormones

- Stressor

- A stimulus that challenges the body's homeostasis and triggers arousal

- Stress Response

- The physiological and behavioral arousal and any attempt to reduce the stress
- Two sequences
  - **Fast-acting:** Activation of sympathetic nervous system; "fight-or-flight" response
  - **Slow-acting:** Activation of parasympathetic nervous system; "rest-and-digest" response

1

In the fight-or-flight response, the hypothalamus sends a neural message through the spinal cord.

2

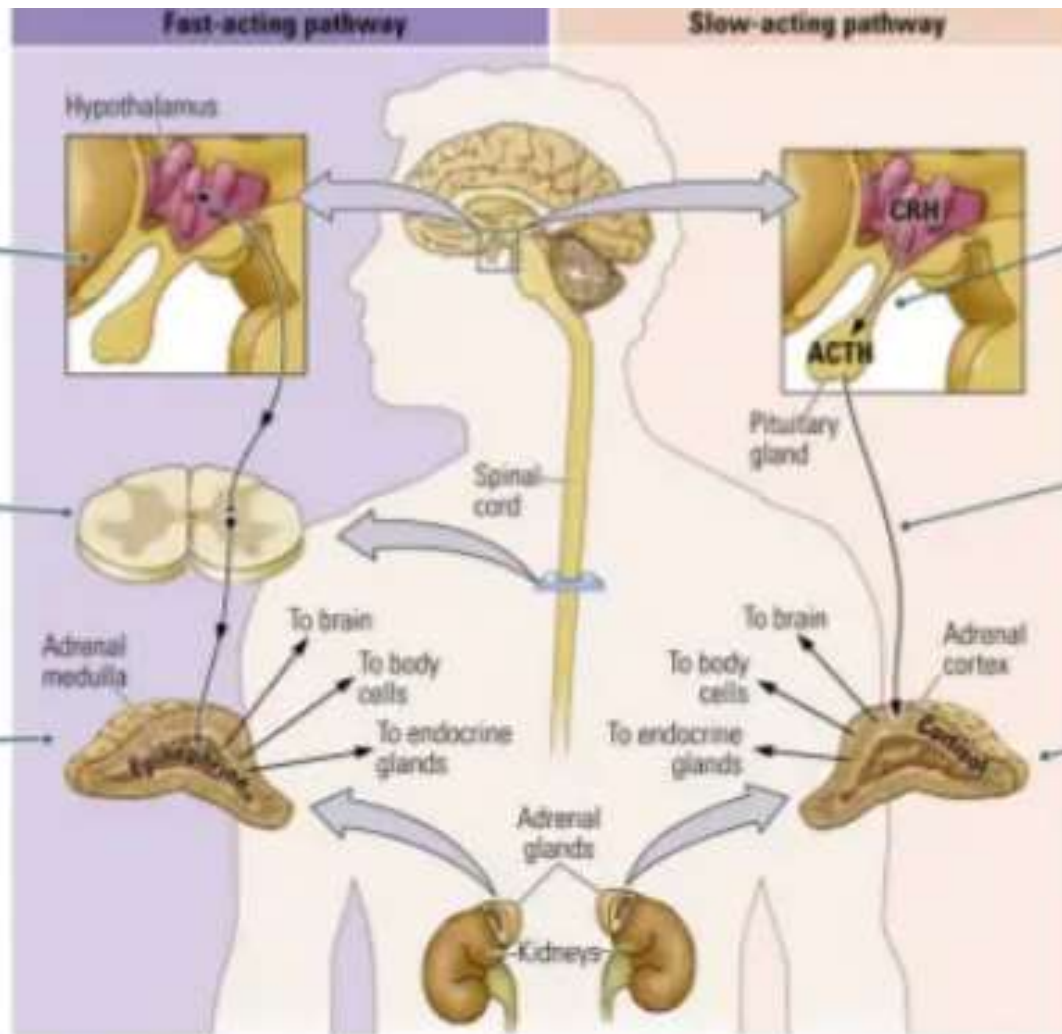
The sympathetic division of the autonomic nervous system is activated to stimulate the medulla of the adrenal gland.

3

The adrenal medulla releases epinephrine into the circulatory system.

4

Epinephrine activates the body's cells, endocrine glands, and the brain.



1

In the brain, the hypothalamus releases CRH into the pituitary gland.

2

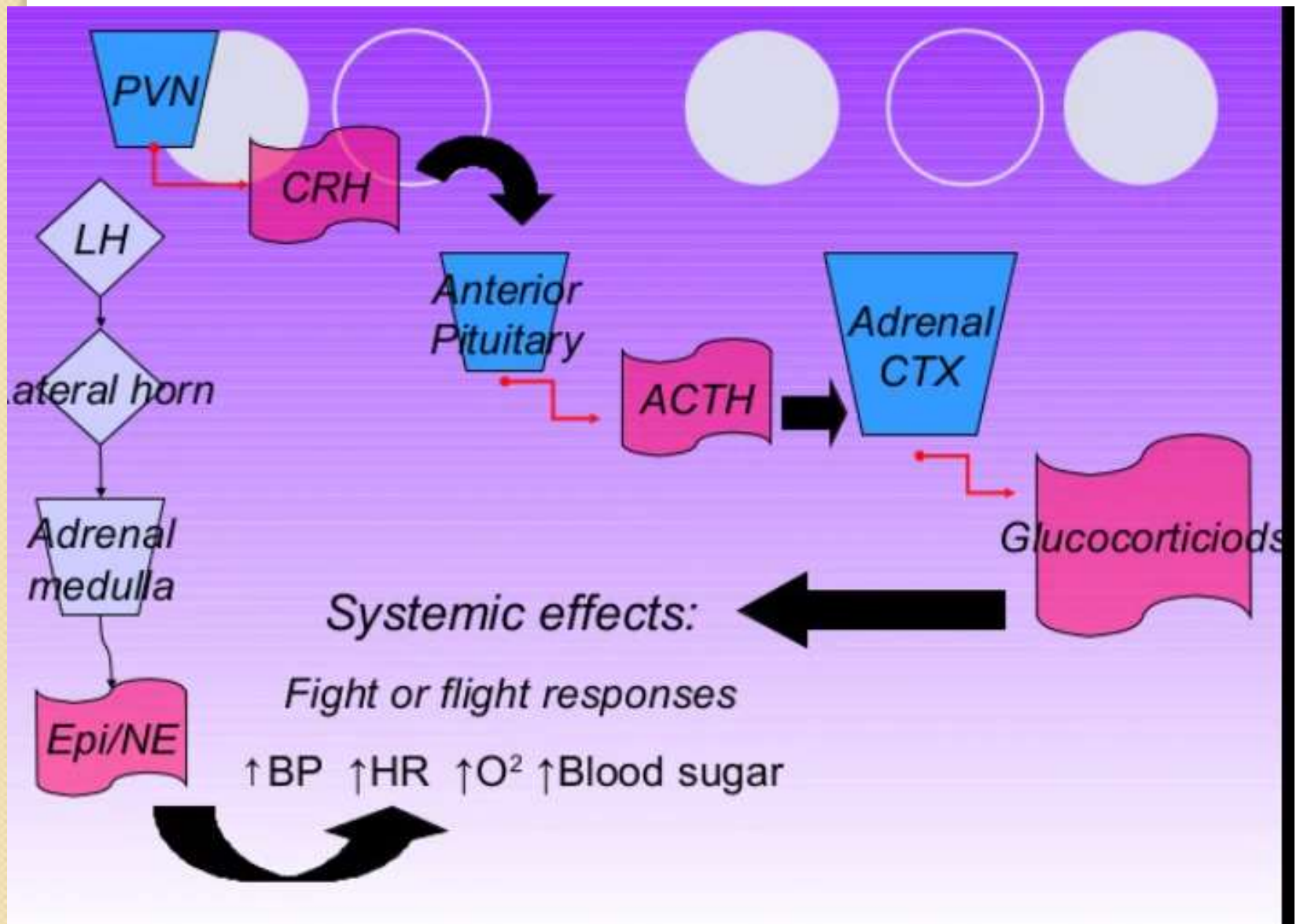
The pituitary gland releases ACTH, which acts on the cortex of the adrenal gland.

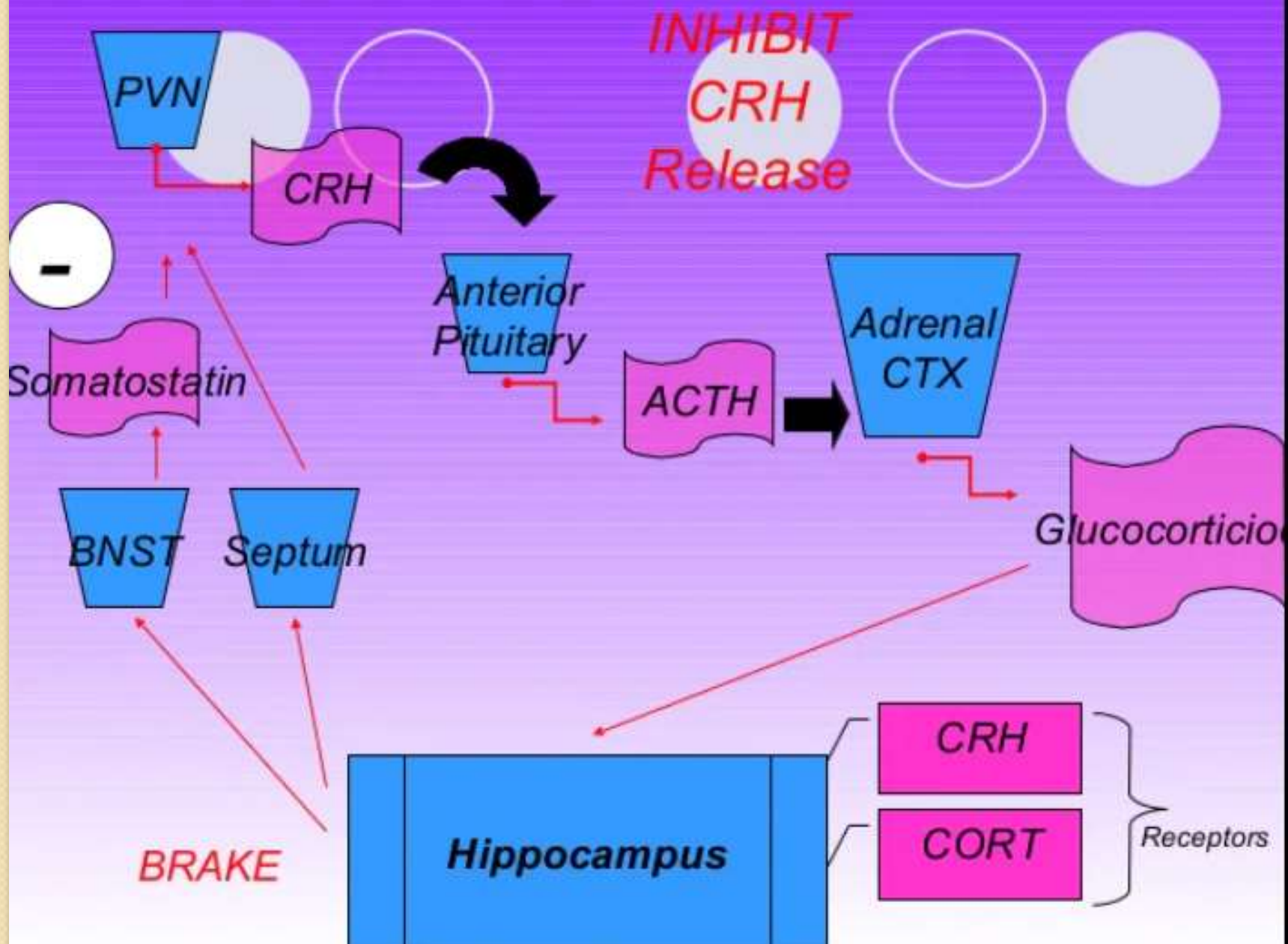
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The adrenal cortex releases cortisol into the circulatory system.

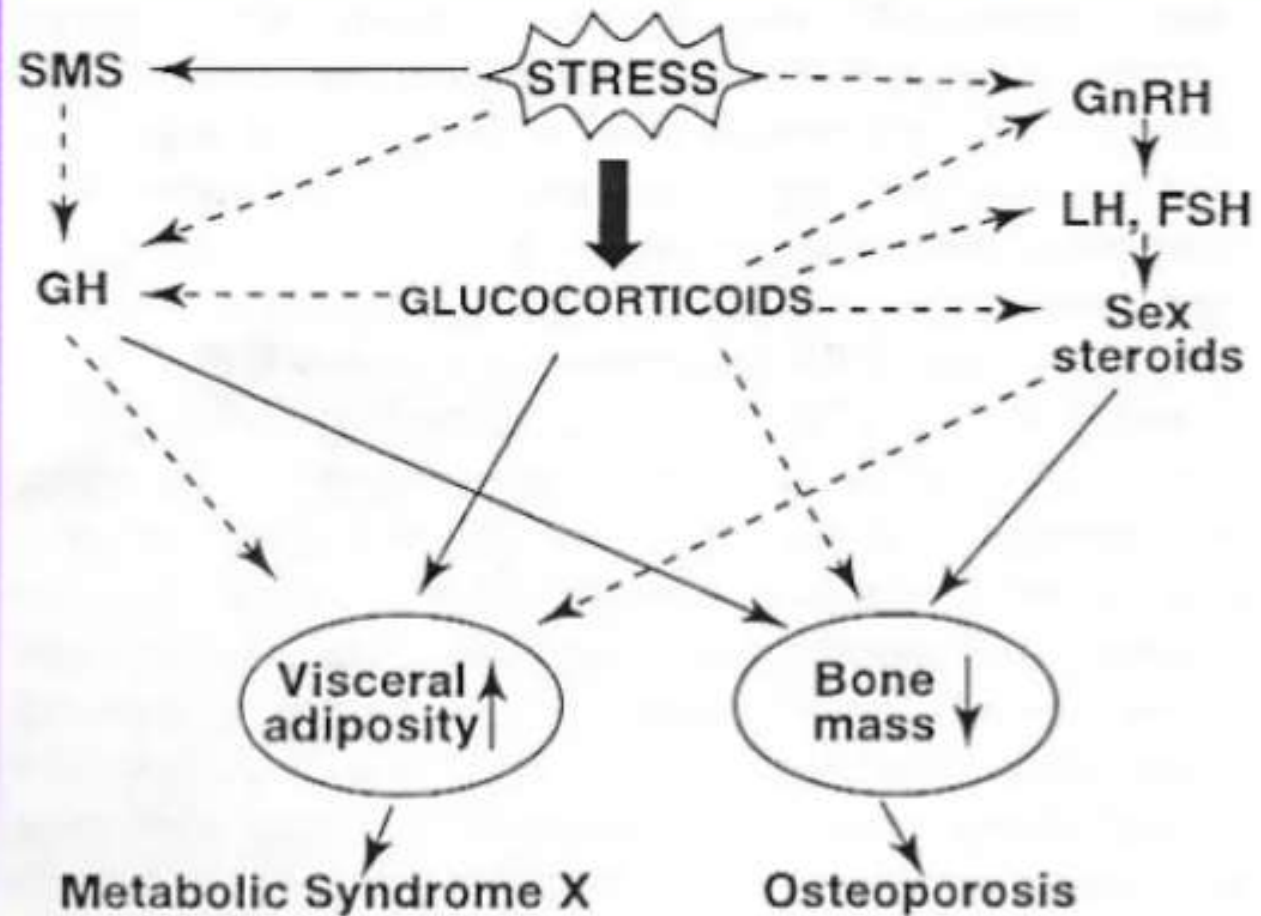
4

Cortisol activates the body's cells, endocrine glands, and the brain.





# Chronic Stress and Hypothalamic integration



- Stress Disorders

- Psychoneuroimmunology

- Psychoneuroimmunology:

- The branch of neuroscience involved with interactions between environmental stimuli, the nervous system, and the immune system.

- Antigen:

- A protein present on a microorganism that permits the immune system to recognize the microorganism as an invader.

- Stress Disorders

- Psychoneuroimmunology

- Cytokine:

- A category of chemicals released by certain white blood cells when they detect the presence of an invading microorganism; causes other white blood cells to proliferate and mount an attack against the invader.

