

Endocrine System

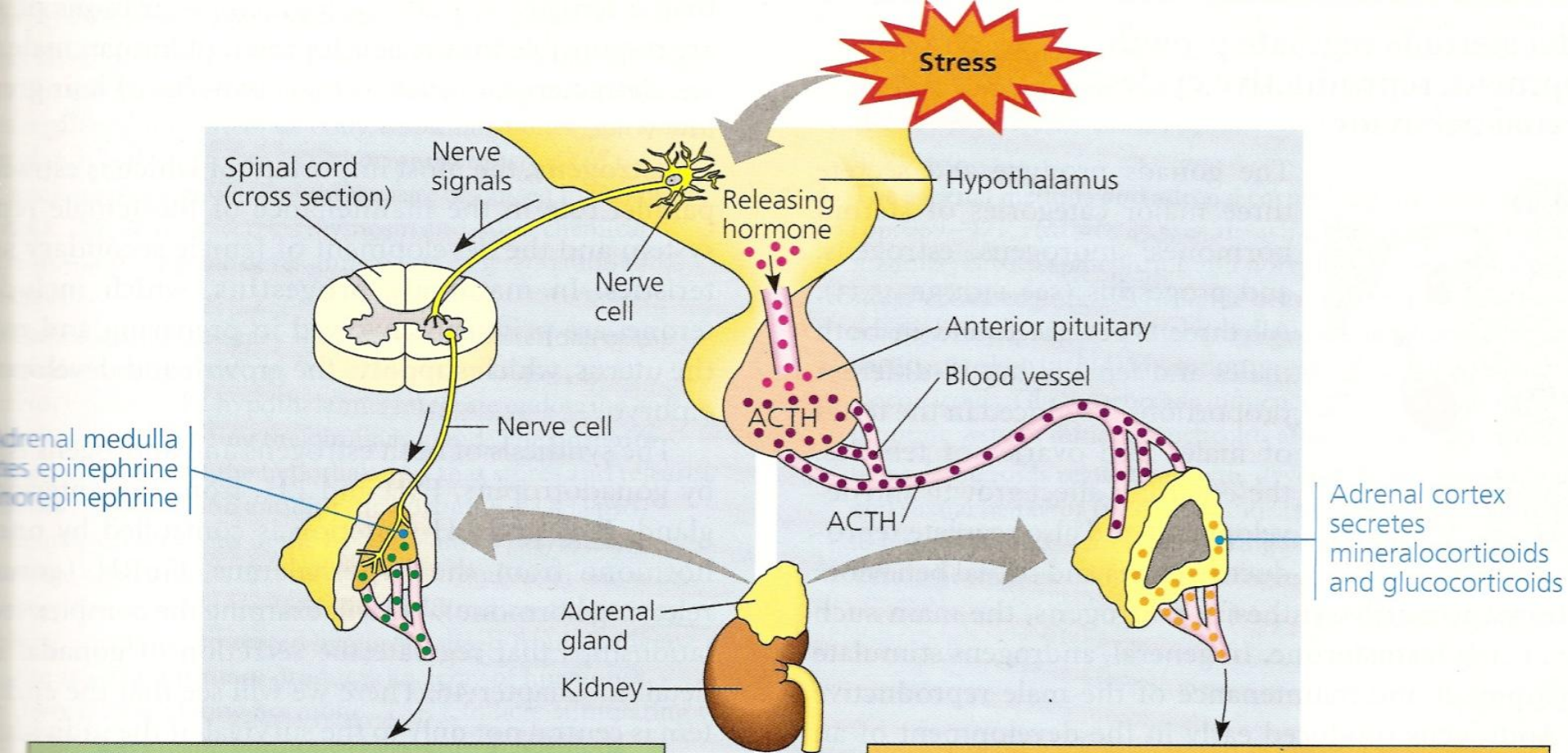
Stress Regulation

What is stress?

- The feeling of alarm or distress when reacting to particular event
- Can be physical, emotional, cognitive or mental

Stress Response

- Natural response
- Prepares an individual to handle the stressor (an event that provokes stress)
- Types:
 - Short term: responses are immediate
 - Long term: responses are ongoing and can cause detrimental side effects on the individual



Short-term stress response

Effects of epinephrine and norepinephrine:

1. Glycogen broken down to glucose; increased blood glucose
2. Increased blood pressure
3. Increased breathing rate
4. Increased metabolic rate
5. Change in blood flow patterns, leading to increased alertness and decreased digestive and kidney activity

Long-term stress response

Effects of mineralocorticoids:

1. Retention of sodium ions and water by kidneys
2. Increased blood volume and blood pressure

Effects of glucocorticoids:

1. Proteins and fats broken down and converted to glucose, leading to increased blood glucose
2. Immune system may be suppressed

Adrenal Gland

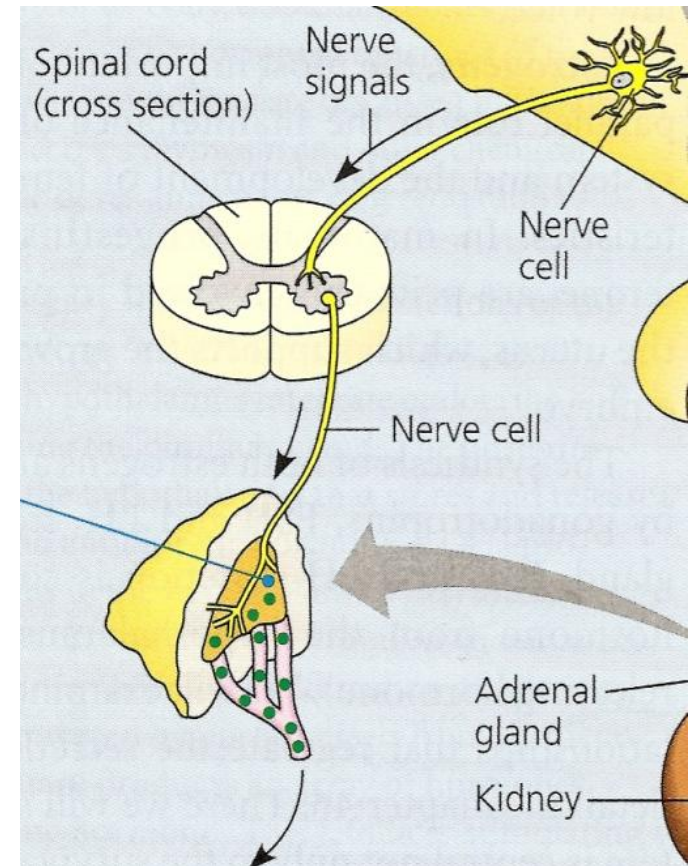
- Secretes stress response hormones
- Location: adjacent to kidneys
- Structure:
 - Adrenal **cortex** : outer portion, involved with long-term stress response
 - Adrenal **medulla** : inner portion, involved with short-term stress response

Short Term Stress Response



Short-term Stress Response

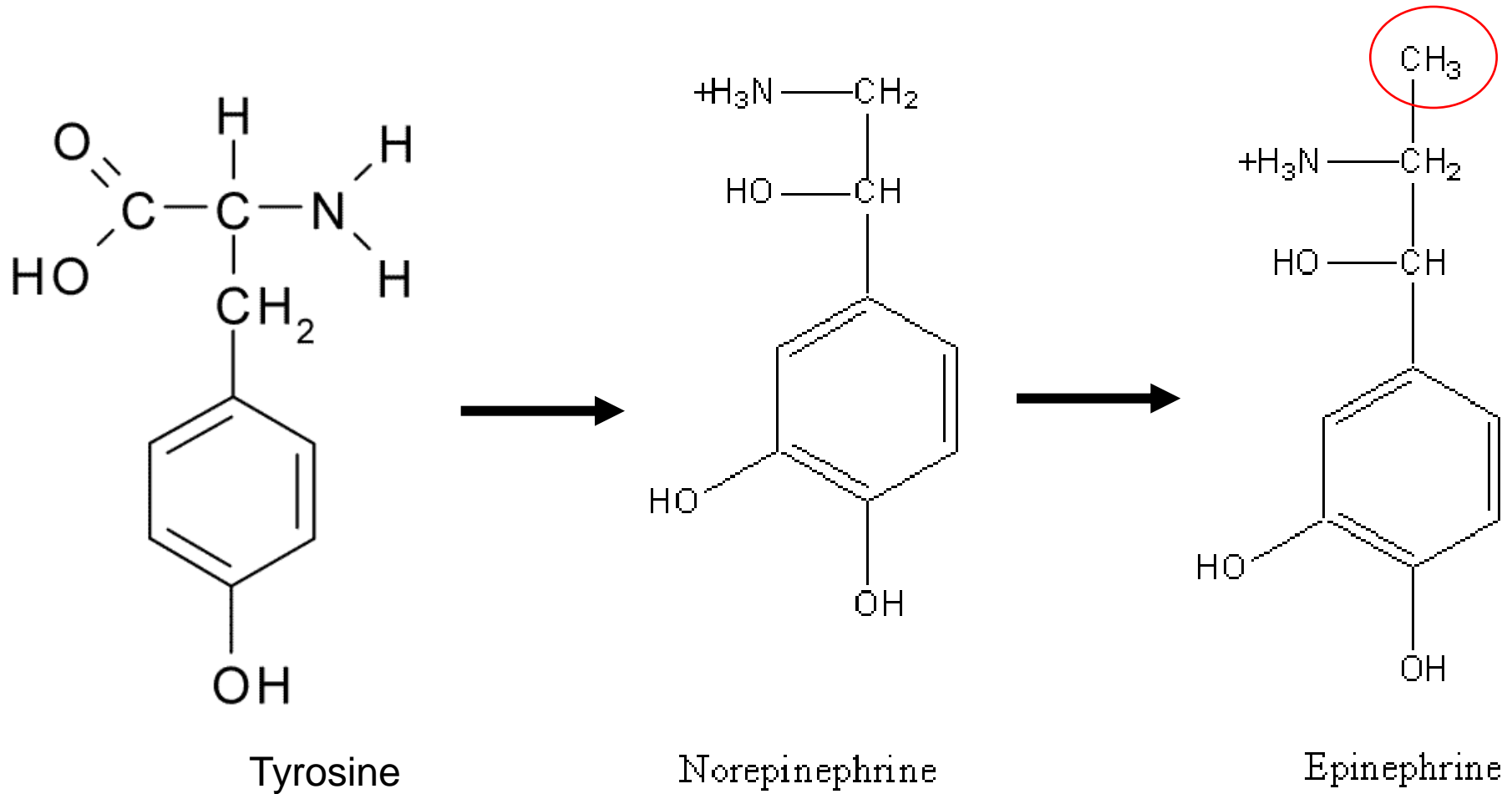
- Stress excites nerve cells to release a neurotransmitter: acetylcholine (ACh)
- Stimulates **adrenal medulla** to release catecholamines: epinephrine and norepinephrine



Catecholamines

- Synthesized from tyrosine
- Secreted in response to positive or negative stress by the adrenal medulla
- Types:
 - Epinephrine (adrenaline)
 - Norepinephrine (noradrenaline)

Catecholamines



Effects

- Stimulates the “fight-or-flight” response
- Increase metabolism
 - Cellular respiration produces ATP
 - Need energy source (glucose)
 - Need oxygen

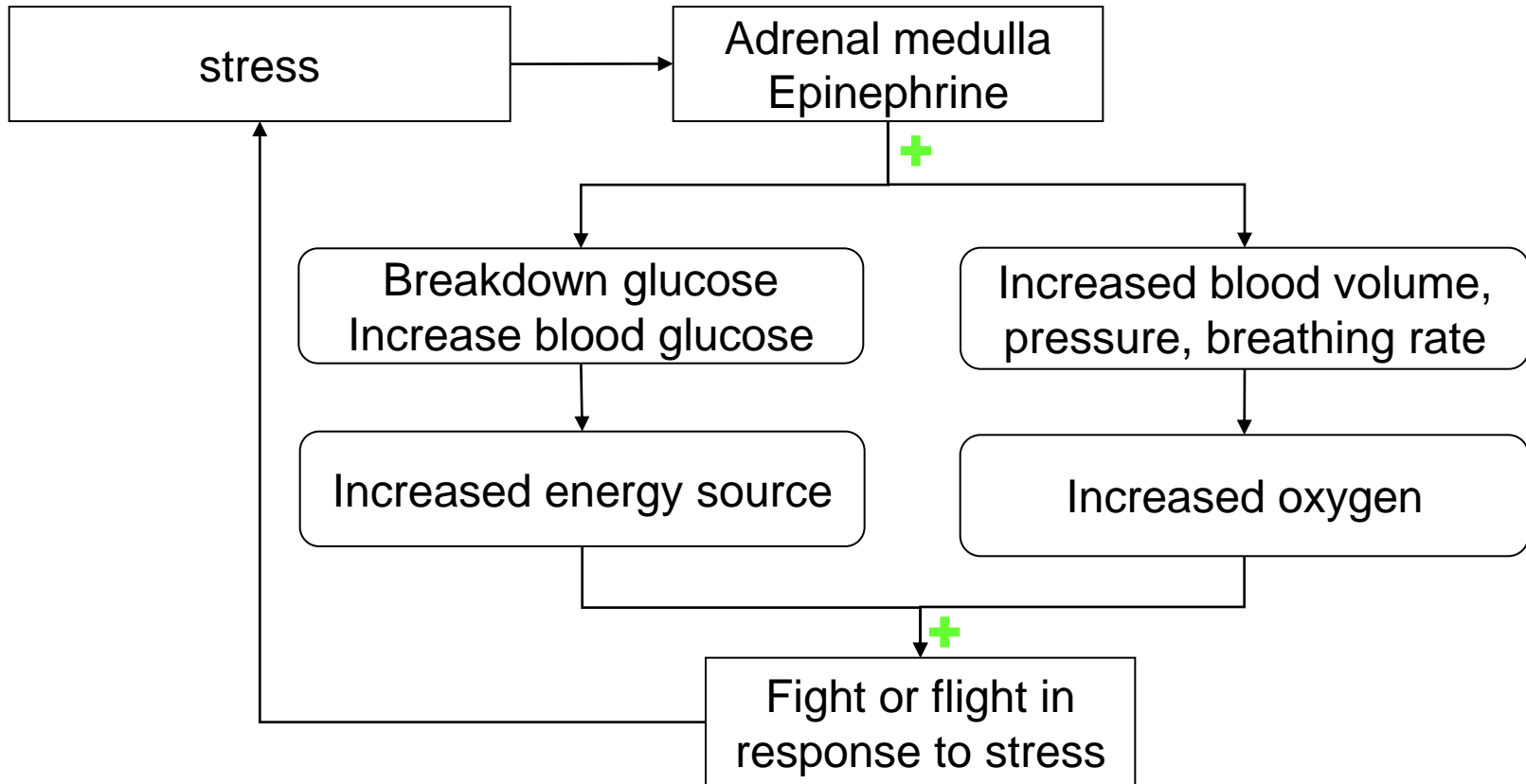
Effects: Energy Source

- Increased blood glucose levels
 - Glycogen → glucose
 - more ATP readily available
- Stimulates the release of fatty acids from fat cells to supply the body with more energy
- Decreased kidney and digestive activity

Effects: Oxygen

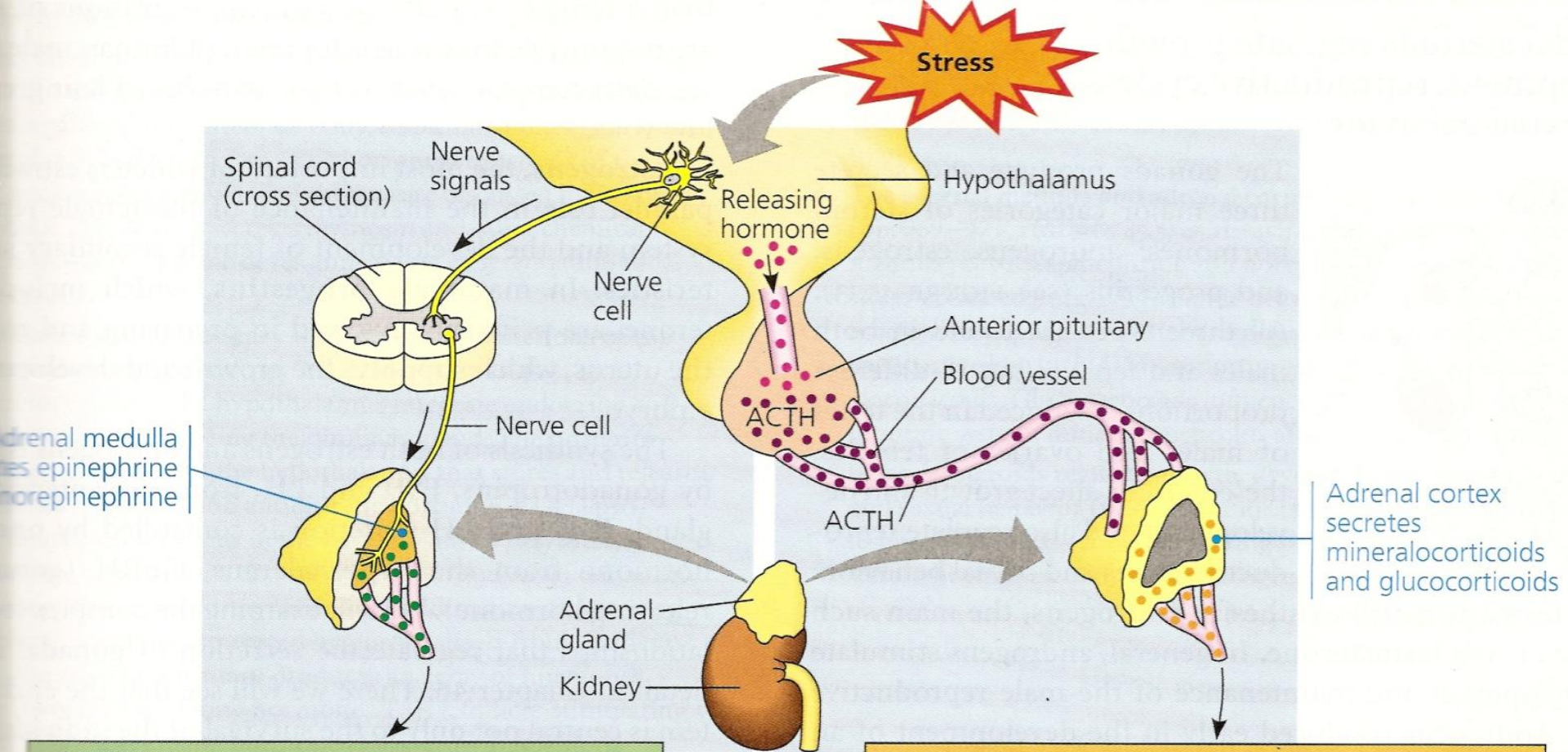
- Increased blood pressure and blood flow
 - oxygen is distributed to cells faster
- Increased breathing rate
- Relaxes/contracts certain blood vessels
 - overall effect of redirecting blood away from non-vital areas
 - increasing blood flow to the heart, brain, and skeletal muscles
- Increased alertness

Short-term Stress Response



Application

- Epinephrine is present in epinephrine autoinjectors (EpiPens)



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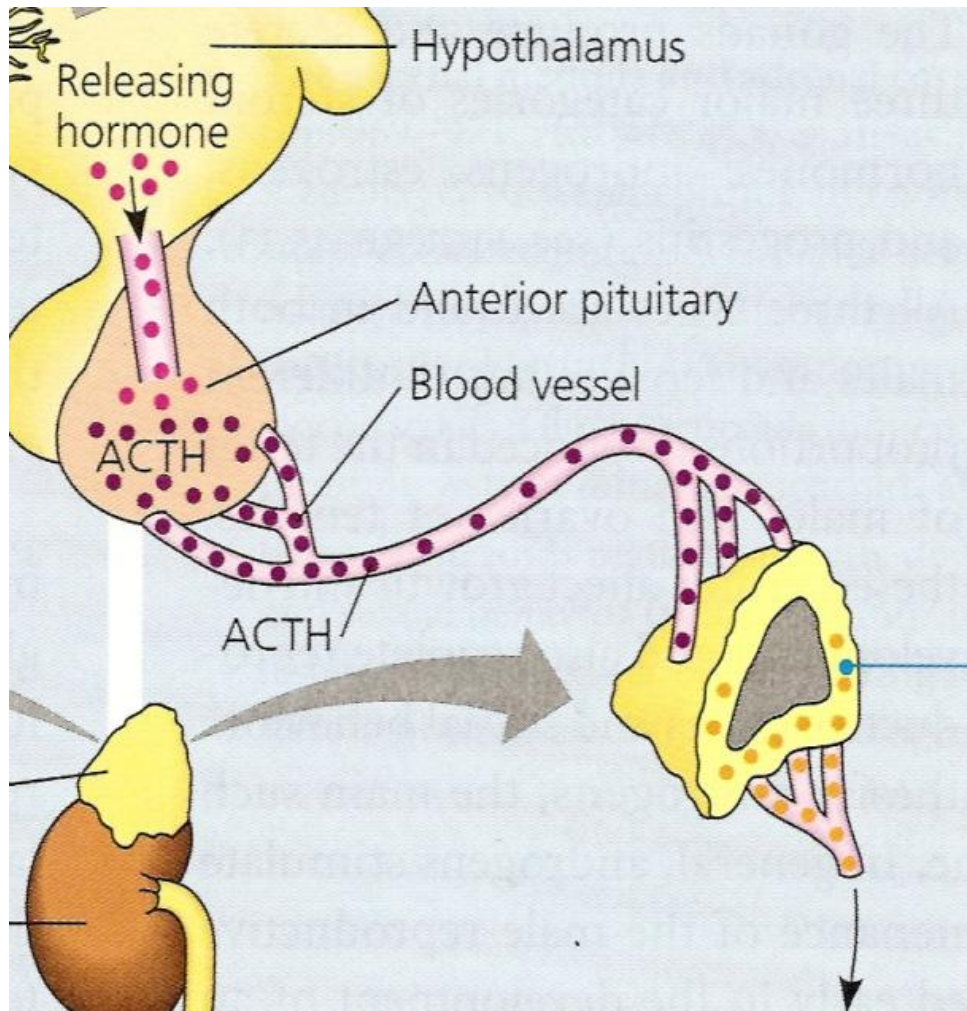
1. Proteins and fats broken down and converted to glucose, leading to increased blood glucose
2. Immune system may be suppressed

Long Term Stress Response



Stress? What stress?

Long-Term Stress Response: Neuroendocrine pathway



- CRH
- ACTH
- Corticosteroid
 - Glucocorticoid
 - Mineralcorticoid

Adrenal cortex
secretes
mineralocorticoids
and glucocorticoids

Long-Term Stress Response: Neuroendocrine pathway

Location	Hormone
Stimulus	Stress
Hypothalamus	Corticotropin-releasing Hormone (CRH)
Anterior Pituitary	Adrenocorticotrophic Hormone (ACTH)
Adrenal Cortex	Corticosteroids: Glucocorticoids (e.g. cortisol) Mineralocorticoids (e.g. aldosterone)
Effect	Increase glucose production Increase oxygen delivery

Corticotropin-Releasing Hormone (CRH)

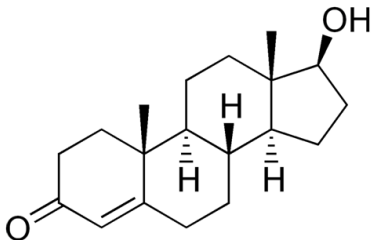
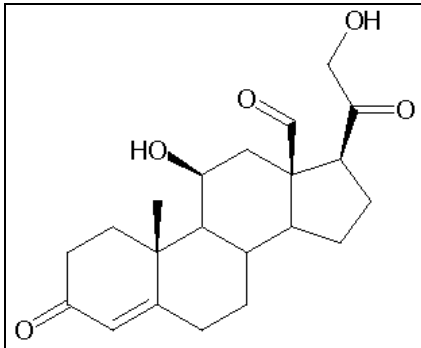
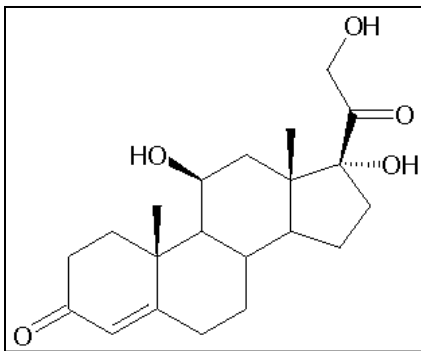
- Peptide hormone
- Tropic hormone
- Released from hypothalamus
- Stimulus: stress
- Effect: Stimulates anterior pituitary to synthesize ACTH

Adrenocorticotrophic Hormone (ACTH)

- Peptide hormone
- Tropic hormone
- Produced from anterior pituitary
- Effect: Stimulates adrenal cortex to synthesize corticosteroids

Corticosteroids

- steroids produced and released from the **adrenal cortex**



Type	Example
Glucocorticoid	Cortisol
Mineralcorticoid	Aldosterone
Sex hormones	testosterone

Glucocorticoid (Cortisol) Effects:

Energy source

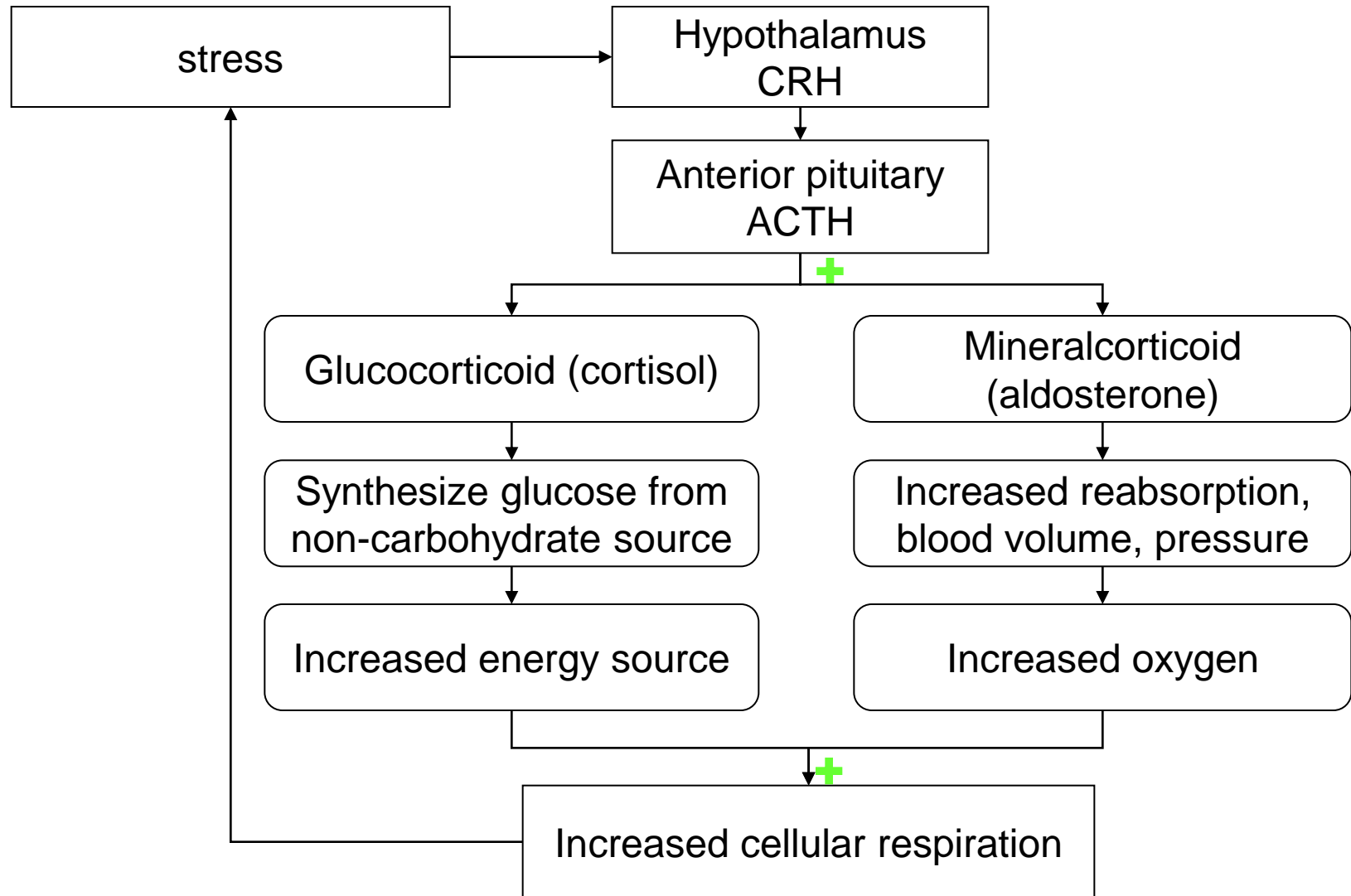
- Affects glucose metabolism
- Raise blood glucose levels by synthesizing glucose from **non-carbohydrate** sources:
 - Breakdown of fat to glucose
 - Liver breaks down muscle protein in skeletal muscles to glucose
 - Occurs when body needs more glucose than what the liver can produce from its storage of glycogen
- Other effects:
 - Suppress immune system
 - Natural anti-inflammatory (antihistamine)

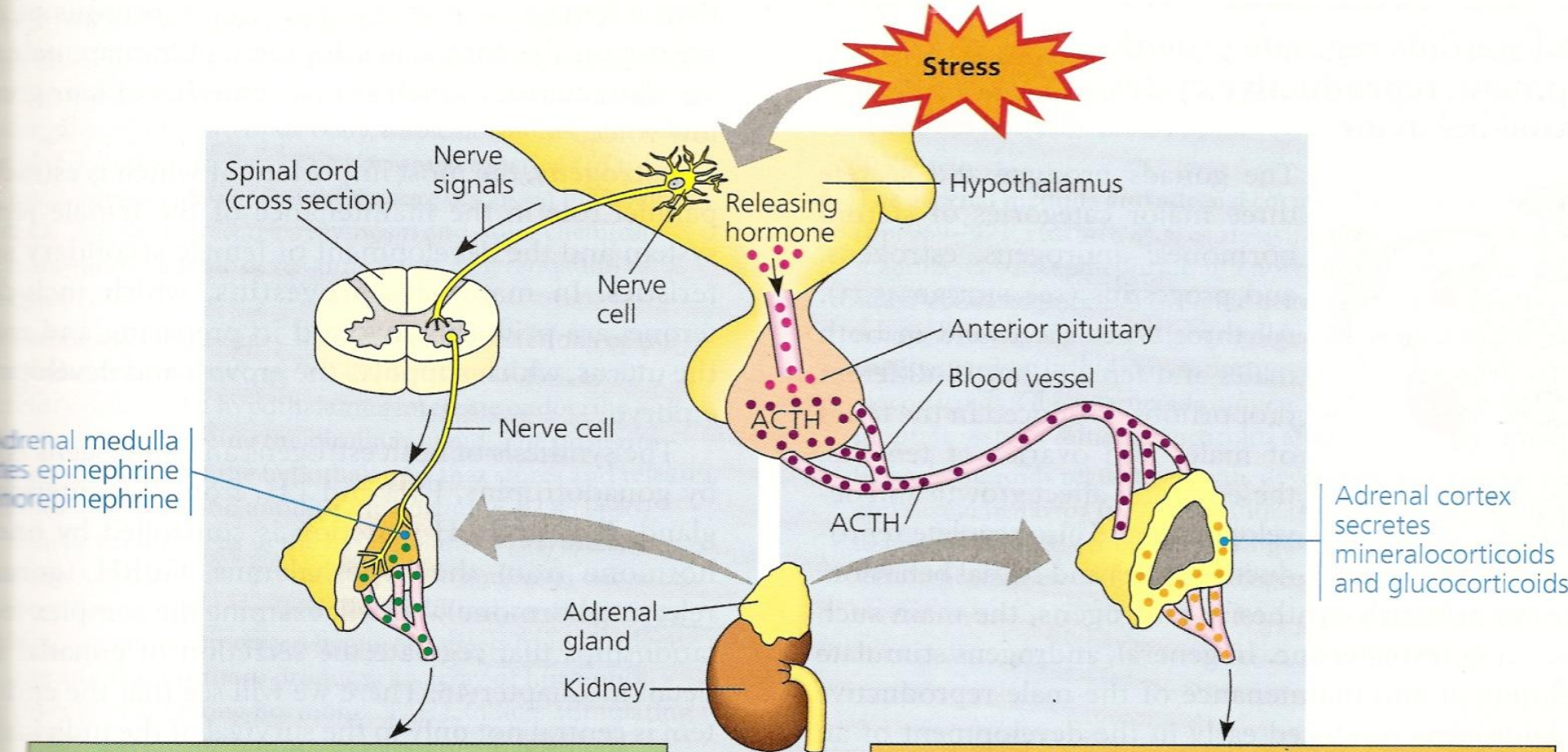
Mineralocorticoid (Aldosterone)

Effects: Indirectly on oxygen

- Hormone that affects the body's osmotic balance
 - Stimulates **reabsorption** of salt and water by kidneys
- Cause increase in **blood volume and pressure**
- Increase oxygen delivery

Long-term Stress Response





Short-term stress response

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Compare Short & Long Term Stress Management

Stress	Short term	Long term
Hormones	Epinephrine Norepinephrine	Glucocorticoid (cortisol) Mineralcorticoid (aldosterone)
Energy	Glucose from glycogen stores	Glucose from non-carbohydrate source
Oxygen	Increase heart rate, pressure, flow & resp rate, regulate vessel size	Increase reabsorption of salt and water, blood volume, pressure & flow

Stress Associated Disorders



Cushing's Disease: Hypersecretion

- Overproduction of glucocorticoid (**cortisol**)
- Mimic diabetes:
 - Hyperglycemia (high blood glucose)
 - Glucosuria (glucose in urine)
 - Protein shortage (protein converted to glucose)

Cushing's Disease: Physical Effects

- Excess glucose deposited as body fat in abdomen, face, above shoulder blades
 - Weight gain, “moon face” and “buffalo hump”
- Appendages remain thin
- Muscle weakness, prone to bruising
- Weak skeleton, prone to fractures

